MicroComputer JOURNAL

The print forum for the MicroComputer professional and semi-professional

July/August 1994

Pioneer's DRM-604X Mini-Changer Breaks The CD-ROM Bottleneck

- How To Build Robot Power Systems
- What It Really Costs To Upgrade To OS/2 2.1
- Exploring Hard-Disk Compression

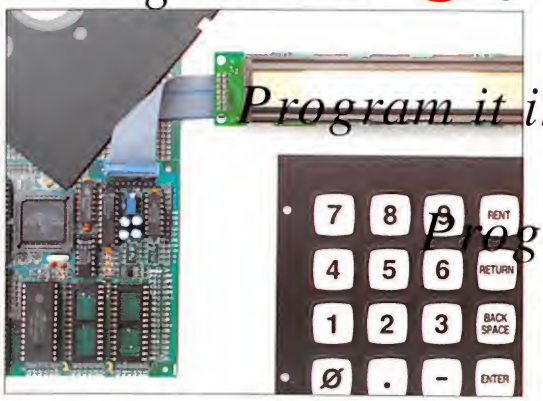
U.S. $4.95

08

0 74851 08559 2

68HC11 Controller & Languages

Program it in **C** *or*



Program it in **Basic** *or*

Program it in **FORTH** *or*

Program it in **Assembly**

$99

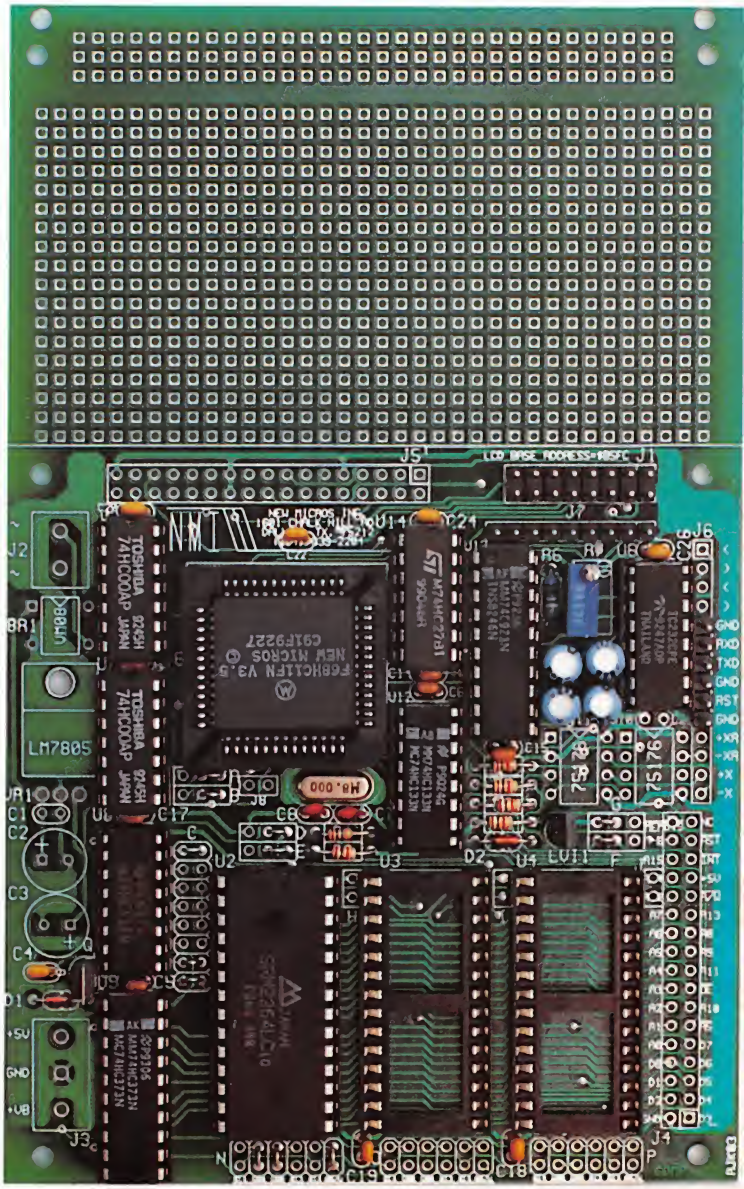
Low Cost Development Package: Controller + Languages + Manuals on disk included!

Package Price Breakthrough!

The NMIT-0020 Single Board Computer is perfect for dedicated controller with convenient interfaces for LCD displays and keypad. Intelligent LCD's up to 2 lines by 80 characters and matrix keypads up to 4x5 can be used. The processor is the popular F68HC11 with many features, including SCI and SPI serial channels, 8-bit 8-ch. A/D, 20 available I/O lines, Watch Dog Timer, 1/2K EEPROM and Max-FORTH w/Floating Point Package embedded in 12K internal ROM. SBC expands F68HC11 providing 3 28-pin JEDEC sockets for 8-32K RAMs, ROMs, EPROMs, EEPROMs, etc. RS-232 conversion supplied. Requires external regulated supply: 5V at ~30 mA. Based on NMIX-0020 board, so many features may be added as desired by the user (or by factory - call for details & prices).

Languages supplied on accessory disk: Small C, Basic, and Assembler. FORTH resident on chip (may be disabled). Languages come with manuals on disk. Communications utility, MAXTALK included to allow PC clone to act as terminal for download and development. WIPE utility included allows internal ROM, EEPROM, WDT to be enabled/disabled, and EEPROM to be erased. Manuals on disk: UM-MAX Max-FORTH Users Manual, HM-20 NMIX-0020 Hardware Manual, Small C manuals with examples, BASIC11E9 Manual.

SBC and utility disk - $99. Keypad and LCD not included. Great value. Call today! New Micros, Inc. 214-339-2204

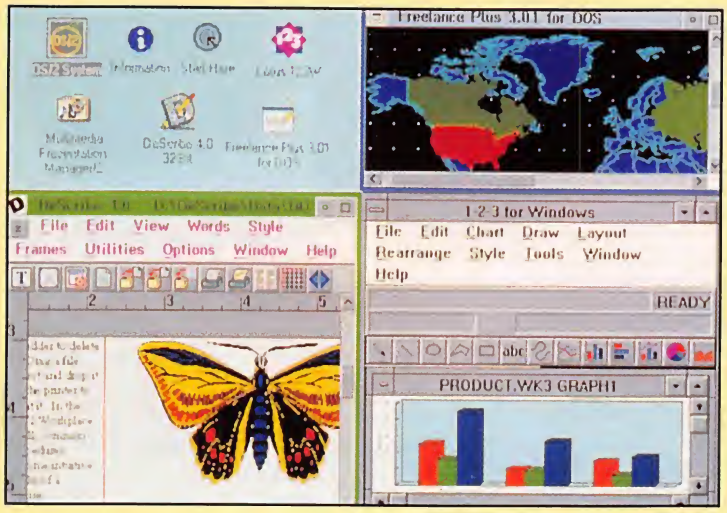


NEW MICROS, INC.
1601 Chalk Hill Road
Dallas, Texas 75212
Tel: (214)-339-2204

CIRCLE NO. 73 ON FREE INFORMATION CARD

MicroComputer JOURNAL

Volume 1, No. 4, July/August 1994



page 57

page 88

page 102

Features

TECHNOLOGY UPDATE

900 MHz breakthrough!

New technology launches wireless speaker revolution...

Recoton develops breakthrough technology which transmits stereo sound through walls, ceilings and floors up to 150 feet.

Breakthrough wireless speaker design blankets your home with music.

By Charles Anton

If you had to name just one new product "the most innovative of the year," what would you choose? Well, at the recent *International Consumer Electronics Show*, critics gave Recoton's new wireless stereo speaker system the *Design and Engineering Award* for being the "most innovative and outstanding new product."

Recoton was able to introduce this whole new generation of powerful wireless speakers due to the advent of 900 MHz technology. This newly approved breakthrough enables Recoton's wireless speakers to rival the sound of expensive wired speakers.

Recently approved technology. In June of 1989, the *Federal Communications Commission* allocated a band of radio frequencies stretching from 902 to 928 MHz for wireless, in-home product applications. Recoton, one of the world's leading wireless speaker manufacturers, took advantage of the FCC ruling by creating and introducing a new speaker system that utilizes the recently approved frequency band to transmit clearer, stronger stereo signals throughout your home.

150 foot range through walls!

Recoton gives you the freedom to listen to music wherever you want. Your music is no longer limited to the room your stereo is in. With the wireless headphones you can listen to your TV, stereo or CD player while you move freely between rooms, exercise or do other activities. And unlike infrared headphones, you don't have to be in a line-of-sight with the transmitter, giving you a full 150 foot range.

The headphones and speakers have their own built-in receiver, so no wires are needed between you and your stereo. One transmitter operates an unlimited number of speakers and headphones.

Recoton's transmitter sends music through walls to wireless speakers over a 75,000 square foot area.

Crisp sound throughout your home. Just imagine being able to listen to your stereo, TV, VCR or CD player in any room of your home without having to run miles of speaker wire. Plus, you'll never have to worry about range because the new 900 MHz technology allows stereo signals to travel over distances of 150 feet or more through walls, ceilings and floors without losing sound quality.

One transmitter, unlimited receivers. The powerful transmitter plugs into a headphone, audio-out or tape-out jack on your stereo or TV component, transmitting music wirelessly to your speakers or headphones. The speakers plug into an outlet. The one transmitter can broadcast to an unlimited number of stereo speakers and headphones. And since each speaker contains its own built in receiver/amplifier, there are no wires running from the stereo to the speakers.

Full dynamic range. The speaker, mounted in a bookshelf-sized acoustically constructed cabinet, provides a two-way bass reflex design for individual bass boost control. Full dynamic range is achieved by the use of a 2" tweeter and 4" woofer. Plus, automatic digital lock-in tuning guarantees optimum reception and eliminates drift. The new technology provides static-free, interference-free sound in virtually any environment. These speakers are also self-amplified; they can't be blown out no matter what your stereo's wattage.

Stereo or hi-fi, you decide. These speakers have the option of either stereo or hi-fi sound. You can use two speakers, one set on right channel and the other on left, for full stereo separation. Or, if you just want an extra speaker in another room, set it on mono and listen to both channels on one speaker. Mono combines both left and right channels for hi-fi sound. This option lets you put a pair of speakers in the den and get full stereo separation or put one speaker in the kitchen and get complete hi-fi sound.

These wireless stereo headphones have a built-in receiver.

Factory direct savings. Our commitment to quality and factory direct pricing allows us to sell more wireless speakers than anyone! For this reason, you can get these speakers far below retail with our 30 day *"Dare to Compare"* money-back guarantee and full one year manufacturer's warranty. For a limited time, the Recoton transmitter is only $69. It will operate an unlimited number of wireless speakers priced at $89 and wireless headphones at $59 each. Your order will be processed in 72 hours and shipped UPS.

Recoton Transmitter (you must have a transmitter to operate speakers and headphones).....**$69** $4 S&H

Wireless products compatible with the Recoton transmitter:

Recoton Wireless Speaker.....**$89** $6 S&H

Recoton Wireless Headphones.....**$59** $4 S&H

Please mention promotional code **161-CC1104.**

For fastest service call toll-free 24 hours a day

800-992-2966

DISCOVER MasterCard VISA AMERICAN EXPRESS

To order by mail send check or money order for the total amount including S&H (VA residents add 4.5% sales tax). Or charge it to your credit card by enclosing your account number and expiration date. Send to:

COMTRAD INDUSTRIES

2820 Waterford Lake Drive Suite 106
Midlothian, Virginia 23113

AWARD WINNING WIRELESS SPEAKER

Built-in receiver and amplifier:

The wireless speaker and headphones both contain a built-in receiver and amplifier. Signals are picked up and transmitted as far as 150 feet away through walls without the use of wires.

Size: 9"H x 6"W x 5.5"L
Signal-to-noise ratio: 60 dB
Channel Separation: 30 dB
Two-way bass reflex design
10 watts/channel RMS amps
Frequency Response: 50 Hz-15 KHz

Don't take our word for it. Try it yourself. We're so sure you'll love the new award-winning Recoton wireless speaker system that we offer you the **Dare to Compare Speaker Challenge.** Compare Recoton's rich sound quality to that of any $200 wired speaker. If you're not completely convinced that these wireless speakers offer the same outstanding sound quality as wired speakers, simply return them within 30 days for a full "No Questions Asked" refund.

Recoton's Design and Engineering Award

CC-1105

Columns

Departments

In This Issue

With the release of its DRM-604X mini-changer, Pioneer sets a new standard for CD-ROM drive manufacturers to emulate. As Tom Benford points out on page 79, the DRM-604X is, quite simply, the fastest CD-ROM drive currently on the market, operating at up to four times normal speed. Furthermore, this easy-to-install SCSI-interface (it uses a Future Domain interface card or a proprietary Pioneer card) drive lets a user load up to six CD-ROMs in a special magazine that the drive cycles through on demand. Even with six logical CD-ROM drives on-line, the DRM-604X occupies only a single SCSI slot.

You've probably already heard about Intel's new 100-MHz microprocessors for the PC platform and are now more than ever confused by the variety of CPUs from which to choose. Beginning on page 27, TJ Byers clarifies the issue by giving you an insight on both the new Pentiums and IntelDX4 chips.

Next, turn to pages 54 and 57 to get the low-down on installing OS/2 in your system and what it will really cost you beyond the operating environment itself to get the most out of OS/2 2.1 on your 386 or 486 PC from Hardin Brothers and Steven Sweet.

On page 15 Steve Montgomery introduces you to what you need to know to properly build power systems for robotics and other portable devices. Then, on page 41, Fred Eady gives you the low-down on the PIC16C71 microcontroller, including a low-cost programmer for it..

Cover Photo By Lorinda Sullivan

MicroComputer Journal on MCI Mail

You can contact *MicroComputer Journal* on MCI Mail directly or through an on-line service, such as CompuServe. Any questions, article proposals, comments, etc., are welcome on this electronic mail box (MCI ID No. 456-3433) or just type: ComputerCraft.

Charting a Course

The small-computer world is a harried one. In short periods of time, we experience important jumps to better hardware technology and follow new upgraded software versions, wholly new programs and utilities and advances in peripherals. You often get a shifting glimmer of what's coming up, maybe. But you really don't know for sure until one day you learn that everyone's jumping on a new bandwagon or intending to do so fairly soon. But what's right for one person or company wouldn't necessarily work for another. There are many considerations to weigh.

On the horizon now is the "information superhighway," for example. This concept has been around for a long time, of course. Now, however, there are serious movements afoot to make it happen. The concept is information and entertainment availability at the consumer's fingertips in unimaginable quantity and choice, 24 hours of every day. One day, it's expected to dwarf what's available now from independent on-line services. This will obviously require enormous integration of services, delivery and receiving systems. But don't look for it very soon.

Step-up decision-making time is already here for some power users, however, which will filter down to others rather quickly. Now we hear talk that 486 computers are dead in the water if you want the processing power needed to keep up with what's happening. In essence, it's Pentium time!

What can a Pentium-based system do for you? Well, it reportedly speeds through *Windows* applications 50% to 100% faster than a 66-MHz 486 PC. Furthermore, it costs only a few hundred bucks more for a lower-end Pentium PC, a couple of thousand more for a truly muscular model.

With Microsoft *Windows* 4.0 coming up next year, a 32-bit version of *Windows* 3.1, you'll require a Pentium to keep up with the computing world. Of course, there are a host of other decisions to make: how much memory you need (at least 16M), hard-disk storage capacity you need (at least 400M), the type of CD-ROM drive you need (dual-speed minimum), whether or not you need local-bus slots on your motherboard (you bet!), the graphics card you need, and so on.

When you draw up a list of your requirements, it's time to fine-tune your buying decision. Should you get a VESA VL-bus or an Intel PCI-bus motherboard, along with traditional ISA, EISA or Micro Channel slots for peripherals that don't require especially high data throughput, such as modems. But if you're not up there with early adopters of fast 32-bit buses, you'll be looking at later local buses with 64-bit data paths. If you're slow making up your mind or filling up your pocketbook, you may wonder if a new PowerPC-based machine is the way to go.

Decisions, decisions! Well, that's the name of the game in personal computing.

Offices: 76 North Broadway, Hicksville, NY 11801. Telephone: (516) 681-2922. FAX (516) 681-2926. MicroComputer Journal is published bi-monthly by CQ Communications, Inc. (ISSN #74851 08559). Subscription prices (payable in U.S. Dollars only): Domestic—seven bi-monthly issues $29.70, fourteen bi-monthly issues $59.40; Canada/ Mexico—seven bi-monthly issues US $32.00, fourteen bi-monthly issues US $64.00; Foreign—seven bi-monthly issues US $34.00, fourteen bi-monthly issues $68.00; Foreign Air Mail—seven bi-monthly issues US $87.00, fourteen bi-monthly issues US $173.00.

U.S. Government Agencies: Subscriptions to MicroComputer Journal are available to agencies of the United States government, including military services, only on a cash with order basis. Request for quotations, bids, contracts, etc. will be refused and will not be returned or processed.

Postmaster: Please send change of address notice to MicroComputer Journal, 76 North Broadway, Hicksville, NY 11801.

ICS gives you gives you the fastest, most powerful computer available from any comparable home-study course!

Get into a money-making career in personal computer repair

The U.S. Dept. of Labor states that many highly-qualified computer repair technicians are earning over $30,000 a year. And the PC repair field is targeted for higher-than-average growth throughout this decade and beyond!

DOS 6
Comes with DOS installed!

Comprehensive PC Repair Video
Takes you step by step through all of the most common PC malfunctions and how to repair them.

PC Tool Kit Includes screwdrivers, chip inserter/extractor, torx screwdriver, nut drivers, insulated tweezers and more.

Professional Diagnostic Card and Diagnostic Software
Enables you to locate and repair almost any computer problem.

Digital Volt-Ohm Milliammeter
Provides voltage, current and resistance measurements, and checks for circuit malfunctions.

When it comes to PC Repair training at home, the choice is overwhelmingly clear...ICS is #1!

Here are just a few advantages ICS gives you that the competition doesn't...

Why settle for a 486SX when ICS gives you a superior, faster 486DLC for less money...

Only ICS gives you:

- Cyrix's 486DLC/33MHz CPU greatly outdistances Intel's i486SX/25 in benchmark testing
- Cyrix's 33 megahertz 486DLC microprocessor.
- IBM-compatible 486DLC with true 32-bit architecture
- 1Kb internal cache plus a high-speed 64Kb external cache
- 2400 baud internal modem
- access to ICS Online with numerous exciting services to choose from
- 256+ color capacity Super VGA high-resolution monitor
- 1.44MB 3.5" floppy disk drive

Plus you also receive...

- Ready to use 80MB IDE hard disk drive
- 1MB RAM expandable to 32MB
- ISA expansion slots
- 101-key enhanced keyboard

ICS is the largest, most recognized at-home training institution in the world...

- Only ICS has trained over 10 million men and women for new careers.
- Only ICS training is used by over 2,000 leading corporations such as IBM, Xerox, Ford, Dupont, and Avon.
- Only ICS gives you easy low monthly payment options with 0% financing.
- Only ICS awards you the renowned ICS Diploma respected around the world.
- As a longstanding member of the National Home Study Council in Washington, D.C., our courses are nationally accredited.

ACCREDITED MEMBER OF THE NATIONAL HOME STUDY COUNCIL

Train at home in your spare time to enter one of the fastest-growing, highest-paying computer careers!

Only ICS, the world's leader in training at home, gives you hands-on practice with a high-performance 486DLC IBM-compatible computer with Cyrix microprocessor, color monitor and internal modem, so you master the latest techniques and innovations in PC servicing and repair. You get the same high-quality training taught at vocational and trade schools but without spending years attending classes. You can complete your training in just months...you'll even be able to start making money doing repair jobs before you finish your course.

Our computer specialists have spared no effort in ensuring that this is the finest PC repair course available through home study.

Compare ICS training—you get better equipment/lower tuition!
Don't be confused by other schools that try to duplicate ICS training. Check the facts by sending for our free information package.

You receive a fully assembled 486DLC IBM-compatible personal computer system!
This high-performance system is all you'll need to learn PC servicing and repair. Step by step you're taught how to troubleshoot, repair/replace all of the major components of this amazing system.

ICS hands-on training is the key to your successful future in PC repair!
You receive practical, real-world computer servicing experience on your 486DLC computer, using the professional tools and diagnostic hardware and software that's included with your course--everything is explained step by step.

Learn to service and repair every type of personal computer!
ICS makes you competent with the latest technology so you'll be able to handle any computer servicing job that comes your way. You'll learn how to set up and configure PC systems...how to replace central processing unit (CPU) components, hard drives, floppy drives, keyboards, monitors and printers...how to detect and deal with computer viruses...how to upgrade PCs and much more.

Your career in PC repair begins with the big, full-color FREE information package we send you when you mail the post-paid card at left.
Get the facts you need on our revolutionary PC repair course. Send for free information that tells how ICS training can start you toward a high-paying career as a PC Service Technician.

34VC

Mail the postage-paid card at left today. If card is missing, mail coupon at right.

OR CALL TOLL FREE:

1-800-596-5505 Ext. 4374

CALL ANYTIME— 24 hours a day, 7 days a week.

ICS SINCE 1890 **School of Computer Training,**
Dept. PCES74S, 925 Oak Street, Scranton, PA 18515

YES! Please send me free facts that tell how I can train at home to learn PC repair. I understand there is no obligation and no salesman will visit me.

Name _____ Age _____

Address _____ Apt. # _____

City/State _____ Zip _____

Phone ( ) _____

27

What's Happening!

COMPUTER FACTORY OUTLETS. Like clothing discounters, computer factory outlets are opening to the public. Dell Computer, for example, operates a warehouse outlet near its headquarters in Austin, TX, where it sells returned computers. IBM has stepped into the outlet field, too, opening a factory outlet in Raleigh-Durham, NC, near its tech center in Research Triangle Park. It will offer discontinued, returned and reconditioned equipment at discounts of 10% to 40% off their retail prices.

DISCOVERING INTERNET. The world's largest computer network, the Internet, which is really a community of networks, rather than a single on-line service, is attracting more attention than ever before. Once the playground for educational and research institutions and government, more and more of the "public" have become active on the Internet through individual accounts. There are a host of new books about this computer communications resource. An exceptionally good, all-around one for new users is "The Internet Guide for New Users" by Daniel Dern, published by McGraw-Hill.

As with any other on-line service, you need an account to get onto the Internet. If you're connected with a university or company that already has one, you're set. If not, you have to scratch around to get one with an operation that has it, which may cost you $10 to $15 per month or more. You can, however, get an account FREE, with unlimited access to everyone in the U.S. through the International Internet Association. Set up by 23-year-old Max Robbins using grant money, just fax to IIA at 202-387-5446 and request an Internet application, leaving your name and address. Again, there's no access charge, but you pay for regular phone costs dialing up IIA's New Jersey node. A more-convenient "800" number is made available, which is billed at 20 cents per minute.

CATALOGS & DATA BOOKS. Linear Technology offers a free infocard on linear and switching voltage regulators for use with Intel's Pentium microprocessor. Call 1-800-4-LINEAR to request "Power for Pentium."... Philips Semiconductors announced its "1994 RF/Wireless Communications Data" handbook, which is available free of charge. It covers application information and design shortcuts. To get this 1,100-page reference and design tool, call 800-447-1500 Ext. 3011.... For designers who need to distribute clock signals, Motorola's "Timing Solution Data Book" (No. BR1333/d) may be just the ticket for you. This 190-page book is available free by calling 1-800-441-2447 or fax your request to 602-994-6430.

Keyboards, mouse and video products are featured in Vetra Systems' free catalog. Among products described are keyboard encoders, keyboard eliminators for PC boot without a keyboard, RS-232 converters to keyboard inputs, multiplexers to connect multiple keyboards or mice to one PC, switches to permit a single keyboard mouse or monitor to control multiple keyboards, keypads for footswitch capability and programmability, and more. Phone 516-454-6469 or fax 516-454-1648.

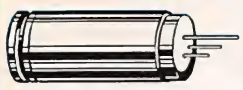
Another keyboard-improvement product line is featured in Hooleon Corp.'s 36-page catalog. It includes add-on keyboards, dual-language keyboards, keytop labels that combine a larger character and Braille raised character for visually disabled persons, single-key lockouts and a variety of other productivity products. Contact Hooleon at 800-937-1337 to request a free catalog.

TECH TRAINING. East Coast Network Training Services implemented a one-stop-shopping bulletin-board system for technical training products. The BBS is available to all corporate training managers, MIS managers, LAN/WAN specialists, programmers, telecommunication specialists and end users. It provides access to nationwide classroom seats, computer-based training, video training programs and self-study kits. Available for download are Windows for Workgroups training, MS Windows NY, Novell, Unix, Banyan, Lantastic and others. Telephone 401-726-6830 (up to 14.4K bps,8,1,N, ANSI).

Ontrack Computer Systems' (tel.: 1-800-752-1333) updated "TechSource for DOS" has become an all-inclusive reference guide for support and repair staffs. Functions include hardware, software and operating-system information, including various jumper settings, hardware and software interaction, and configuration details. Now incorporating DiskSource and SystemSource, it contains specs on more than 3,000 disk drives, jumper settings on more than 1,200 disk drives and 400 controllers cards, and more than 60 BIOS charts, as well as technical information on more than 500 system boards. A user can search by manufacturer, bus type and processor speed. Furthermore, diagrams detail the configuration of jumper and DIP-switch settings, while an infobase provides full error-code descriptions. Price is $799 for the combined package. DiskSource can be purchased separately for $99 and SystemSource for $199.

Celebrating our 12th Year Of Service !!

Collimator Pen



Output: 2.5 mW (max.); Current 90-150 mA
Oper. Volt: 2.2-2.5 V; WI: 820 nm - Infrored
Size: 11 mm dio. x 27 mm L; Data sheet inc.

Stock#	1-9	10-24	25+
SB1052	49.99	47.49	42.74

Collimating Lens

Block anodized aluminum barrel; Glass lens with 7.5mm focal length. Fits 9mm laser diodes sold below. easy to focus and install.

Stock#	1-9	10-24	25+
LSLENS	24.99	23.74	21.37

Eprom Programmer

Programs all EPROMS, EEPROMS, including flash memories. Programs microcontrollers with optional adapters. Complete with software, programming module, cable & manual. Single Device programming.

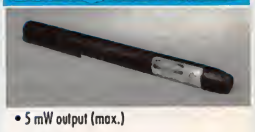
Stock#	1-9	10-24	25+
ROMMAX	159.99	151.99	136.79

Eprom Eraser

Erases up to 9-28 pin or 6-40 pin eproms. Built-in presettable timer with LED intervol indicotor.

Stock#	1-9	10-24	25+
LA6T	89.99	85.49	76.94

Economy Laser Pointer



- 5 mW output (max.)
- 670nm
- 5.75" long
- 2 AAA batt. (inc.)

Stock#	1-9	10-24	25+
B500	99.99	94.99	85.49

Laser Module

- < 4.5 mW output
- 20 mm dio. x 70 mm long
- 150 meters range

Stock#	1-9	10-24	25+
LM4.5	99.99	94.99	85.49

16 More Reasons To Believe In

unicorn ELECTRONICS

Switching Power Supply

- 115/230 V input
- 41 watt
- 5v @ 3.75 A, 12v @ 1.5 A, -12v @ 0.4 A
- 7" L x 5.25" W x 2.5" H

Stock#	1-9	10-24	25+
PS1003	19.99	18.99	17.09

Electronic Experimenters Kit

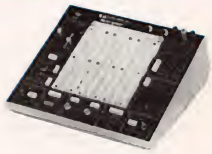
Professor Sparky, world famous inventor, takes you on an entertaining voyage into the world of electronics. No previous knowledge is needed. Choice of 110 (X1000) or 174 (X2000) problem free instructional electronic experiments.

Stock#	1-9	10-24	25+
X1000	43.99	41.79	37.61
X2000	79.99	75.99	68.39

PLUS
•
Low Prices
•
Super Selection
•
Prompt Service
•
Free Shipping
•
Order Toll Free
(800) 824-3432

Protoboard Design Station

Includes expanded instrumentation, breadboard, and power supply. Ideal for analog/digital/microprocessor circuits. Frequency and function generators, variable outputs, logic indicators, speaker & more.

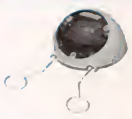


Stock#	1-9	10-24	25+
PB503	299.99	284.99	256.49

Laser Diodes

Stock#	Mfr.	Wavelength	Output	1-9	10-24	25+
LS9200	Toshiba	670nm	3 mW	39.99	37.99	34.19
LS9211	Toshiba	670nm	5 mW	59.99	56.99	51.29
LS9215	Toshiba	670nm	10 mW	109.99	104.49	94.04
LS022	Sharp	780nm	5 mW	13.99	13.29	11.96
SB1053	Phillips	820nm	10 mW	10.99	10.44	9.40

Programmable Robotic Kit



The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words & short phrases ! MV961 comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the attached keypad. With its built-in connector port, and the optional interface kit (WIIIBM), MV961 is ready to communicate with your PC ! The interface kit allows editing and transferring of any movement program, as well as saving and loading of programs.

Stock#	1-9	10-24	25+
MV961	79.99	75.99	68.39
WIIIBM	39.99	37.99	34.19

Robotic Arm Kit

Fascinating and educational, with lift/lower, grab/release, and pivot left/right functions. Uses 2 C batteries (not inc.); approx. 10" long. Use Y01IBM interface to program from your PC!

Stock#	1-9	10-24	25+
Y01	43.99	41.79	37.61
Y01IBM	39.99	37.99	34.19

1/4 Ton IDC Bench Assembly Press

Rotating base plate and platen. No tools required to change plates/cutting accessories . Additional accessories available. Weighs 5.5 lbs. 10" L x 8.75" w x 9" H

Stock#	1-9	10-24	25+
PV505	149.99	142.49	128.24

Computer Care Kit

A complete computer care kit. Contains cleaning diskette, head-cleaning fluid, cleaning swabs, anti-static cleaner, anti-static screen wipes. SB1099 for 3.5" drives, SB1100 for 5.25" drives.

Stock#	1-9	10-24	25+
SB1099	3.99	3.79	3.41
SB1100	3.99	3.79	3.41

Vacuum Base Vise

Panavise PV381 is a versatile, portable bench vise. a half turn of the mount lever attaches or releases the powerful suction pad and allows rapid set-ups in a variety of locations on smooth, non-porous surfaces

Stock#	1-9	10-24	25+
PV381	47.99	45.59	41.03

Telephone Kit

Build this high-tech, see-thru plastic telephone. Learn theory on how telephones work. Flashing neon lamps when phone rings. Redial system and wall mount included. Comes complete with manual

Stock#	1-9	10-24	25+
PT223K	15.99	15.19	13.67

Order Line — (800) 824-3432
Fax Orders — (818) 998-7975
• International Orders — (818) 341-8833
• Technical Support — (818) 341-8833
•Min. Order – $15.00 • UPS Blue, Red, & Fed. Ex. Shipping Avail.• CA Res. Add 8-1/4% Sales Tax
• Open Mon-Fri 9:00 AM - 5:00 PM (PST) • Corporate Accounts / Quantity Discounts Available
•Call For FREE Catalog ($2.00 Outside U.S.) • We Carry A Complete Line Of Electronic Components
*FREE Shipping On Pre-Paid Orders Delivered In The Continental United States

unicorn ELECTRONICS

Unicorn Electronics
10000 Canoga Avenue, Unit C-2
Chatsworth, CA 91311

CIRCLE NO. 105 ON FREE INFORMATION CARD

Reading the Stars

• I was disappointed to see you give advertising to the "Professional Astrology Software" (a true oxymoron) in the "What's New!" section in the October 1993 issue of *ComputerCraft*. It's out of character for a magazine of your quality to give an earnest and positive appraisal of such software. A better location for the review would be the games section.

Brad Congdon
Aloha, OR

Our "What's New!" section doesn't appraise products, just reports their availability. As MicroComputer Journal, *you'll be pleased that such matter won't be covered any longer. The "Games" section has been eliminated, too.—Ed.*

Staff Booster

• You certainly have a fine magazine and staff in *ComputerCraft*. I especially enjoy the articles by Jan Axelson, with their clear-cut "how-to" instructions for building various outboard circuits. Several high-school instructors in my area have been using your publication to help train students to become "computer experts." I hope your new magazine, *MicroComputer Journal*, will retain your excellent editors and contributors.

Charles W. Wilson
Spokane, WA

We're all still here, ready and willing to bring you, our readers, everything you've come to expect from our years as ComputerCraft.*—Ed.*

Leave the Stone Age

• I have been a subscriber for many years (*Modern Electronics* to *ComputerCraft* [now *MicroComputer Journal*]) and have enjoyed your magazines immensely. Throughout the years, they have been one of my major sources for computers and practical technical information. With the knowledge I gained from many wonderful articles, I have been able to upgrade my computer system (Packard Bell AXCEL V IBM-compatible AT 286 operating at 12 MHz) like a pro. Now I am at the end of my rope when it comes to upgrading. Before I retire my old friend, there is a small chance I may be able to give my computer system one last shot in the arm!

Back in July 1991, Roger C. Alford wrote an article on "Upgrading Your 286." Within this article, he called out three do-it-yourself alternatives to turn it into a 386SX. Unfortunately, I'm not familiar with any of the companies mentioned in the article. Therefore, if anyone in your organization can supply me with some information, it will be dearly appreciated. Keep up the great work and quality of your publication.

Glenn E. Miller
Hawthorne, CA

Ps. I'm not the band leader of note!

Forget it! Two and a half years ago, it was a different age. Do yourself a favor and move on up to a new 486 or 486SX computer. It's just not worth the time, effort and money to upgrade an AT-class PC today. Use your present computer as a second machine, a backup or for data-acquisition and control purposes—or give it away to someone or organization.—Ed.

Corrections

• Through an oversight, credit for the photographs in the "General MIDI" article in the January/February issue was omitted. All photos in the article were taken by Liz Benford.

• The telephone number for MIDI Solutions Inc., a source for black-box add-ons, in the Marck/April Multimedia column was missing a digit. The correct telephone number is 604-794-3013.

Hardware

Microcontroller Board

UP Products' 7.37-MHz MS1 Z8671-based microcontroller 32K of memory, an RS-232 port and fully buffered I/O lines provides an easy-to-use system that's programmable in BASIC or Z8 assembly language. The I/O-intensive MS-1 has 65,536 I/O ports, enough control flexibility to meet the requirements of all but the most demanding computer-control enthusiast. With four 8K I/O block-select signals, port addressing is simple and direct.

To set up the MS-1, you load the MS-1.OPS software into the host computer and then connect the included RS-232 and power cables. Interactive programming is done with a PC or any other type of computer/terminal that has an RS-232 port. Off-line programming can be done with any word-processor that's capable of generating ASCII files. ASCII files are loaded into the MS-1 using the MS-1.OPS software or a communication program.

Memory Dump and Move utility programs are pre-loaded into the upper EEPROM chip, along with a start-up data-rate code that sets the MS-1 board for 9,600 baud operation. Eight software-selectable data rates, ranging from 150 to 19,200 baud, are available. Move transfers programs from RAM to EEPROM or EEPROM to RAM and Memory Dump generates a hex-to-ASCII display of the current MS-1 RAM program.

A memory address-sensitive automatic start-up feature executes programs stored in EEPROM without operator intervention, which is a nice feature when the MS-1 is being used as a stand-alone controller. The MS-1.OPS software utilizes the F1 through F10 function keys to activate a series of commonly used macro operations:

Self contained on a 5" X 6" printed-circuit board, the MS-1 consists of 14 ICs, a 50-pin female I/O connector that accepts standard 0.025"-square pins (22-to-26-gauge wire will also work), a DB-9 RS-232 connector and a 7.3728-MHz crystal. Four socketed 8K X eight chips, one RAM and three EEPROMs are supplied. Memory configuration can be modified to meet user requirements. A dc power chip provides 5 volts dc. RS-232 level conversion is on-board. The address, control and data port lines are fully buffered. $124.95, MS-1 controller; $29.95, MS-1.OPS software on 5¼" or 3½" diskette. *UP Products of Connecticut, 52 Susan Ln., North Haven, CT 06473; tel. 203-239-0942.*

CIRCLE NO. 1 ON FREE CARD

Laser Printer Sharing Device

LaserLink MIO from Belkin Components lets you share a single LaserJet printer with up to 10 PCs. The device plugs into Hewlett Packard printers that are equipped with an MIO slot. Once installed, LaserLink MIO may be configured from either the printer panel or through installation software.

Three models are available. The Model 400 has four serial ports, Model 700 has one parallel port and one serial port and Model 1000 has 10 serial ports. All LaserLink models are equipped with 256K of memory, upgrade-able to 12M. With two ports able to be configured as outputs to additional printers, LaserLink MIO doesn't inhibit users who require access to more than one printer. $395/$595/$745, 400/700/1000. *Belkin Components, 1303 Walnut Park Way, Compton, CA 90220; tel.: 800-223-5546.*

CIRCLE NO 2 ON FREE CARD

PC Writing Pad

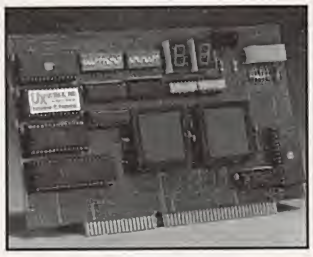
Inforite's MP100 Writing Pad is a pen-based interface for IBM and compatible PCs. When used for input, it collects and translates handwritten information, and when

used for pointing, it works in either relative mode, like a standard mouse, or absolute mode. The 6" X 8" unit is based on pressure sensitive technology, has a 2¼" X 4" active pad area, and a 1,024 X 1,024-point resolution. A Microsoft *Windows* driver is included. $299. *Inforite Corp., 1670 S. Amphlett Blvd., Ste. 100, San Mateo, CA 94402; tel.: 415-571-8766; fax: 415-571-7547.*

CIRCLE NO 3 ON FREE CARD

16-Bit Diagnostic Tool

P.H.D.[16] is a 16-bit test card from Ultra-X for component-level testing of AT 286-, 386-, 486- and Pentium-based systems. This card provides you with a comprehensive range of circuitry diagnostics for system RAM, ROM, DMA controllers, page registers, 8042



keyboard controller, interrupt controllers, timers, CMOS clock and support chips. It uses on-board processor emulation to generate true interrupt and DMA requests to let you troubleshoot failures down to the exact DMA and interrupt line. As each test is conducted, you see the results in simple-to-understand terms right on the screen of your video display. In cases of video failure, test results appear on the on-board display. $799. *Ultra-X, Inc., 2005 De La Cruz Blvd., Ste. 115, Santa Clara, CA 95050; tel.: 408-988- 4721.*

CIRCLE NO 4 ON FREE CARD

PC/AT Single Board Computer

Teknor Microsystems' VIPer-800 and VIPer801 PC/AT single board computers can be configured with 16M of DRAM, 1M of bootable flash EPROM, and 1M SRAM. The 4.8" X 7.1" boards support both IDE and SCSI. PC/104 compatibility allows VIPers to operate either on a passive backplane or in stand-alone embedded applications. VIPer configuration options include an Intel 386SX or a Cyrix 486-SLC microprocessor. VIPer-800 includes local-bus CRT SVGA, while VIPer801 includes local-bus flat panel support. $945/$1,045, 800/801. *Teknor Microsystems, Inc., PO Box 455, Sainte Therese, Qc, Canada J7E 4J8; tel.: 514-437-5682; fax: 514-437-8053.*

CIRCLE NO 5 ON FREE CARD

RS-232 Data Acquisition

Prairie Digital's Model 40 complete serial port data ac-

quisition and control module for PCs features eight analog input channels, 28 digital I/O lines that are individually programmable as either input or output, three stepper-motor controller ports, four channels of relative-resistance measurements, pulse-width-modulation output and battery operation. $99. *Prairie Digital, Inc., 846 17 St., Prairie du Sac, WI 53578; tel.: 608- 643-8599; fax: 608-643-6754.*

CIRCLE NO 6 ON FREE CARD

Sound Effects Playhouse

By Kevin Weiner
(*Waite Group Press. Soft cover. 167 pages. Includes 3½" floppy disks. $24.95.*)

Though sound may be fairly new to the PC in general terms, it may ultimately become the preferred way in which to communicate with your computer in the not-too-distant future. You can get a leg up on this technology with *Sound Effects Playhouse* and the dozens of shareware and freeware programs provided on the included diskettes. This book/disk package provides an easy-to-use, hands-on workshop for creating, editing and playing sounds under DOS and *Windows*.

With this package, you can instruct your PC to perform DOS commands at the sound of your voice or direct the action of a voice-activated game. With the *PC Sound Scope* software included in the package, you can watch sound, speech and music waveforms dance across your video screen. *QSound* samples will have you chasing your tail trying to trace the source of this multi-dimensional effect. Additionally, you can make any program entertaining by playing MIDI music while working with other applications.

The programs included on the two diskettes are designed to work with any Sound Blaster-compatible sound card. With them, you'll learn how to use and convert between sound file formats like .WAV, .VOC, .IBK, .MID and .MOD. You'll also master 3D sound using *QSound* audio samples; explore voice recognition with two voice-controlled games; mix and fade sound files for use in multimedia demos; use special effects like echo, filtering, fading and reversing; edit sound files by cutting, pasting and inserting; link sound and music to DOS and *Windows* events; and turn your keyboard into a simple piano.

The diskettes include 5M of digitized .VOC sound files and 3D clips in .WAV format. They also contain two digital sound editors, .MID- and .MOD-format music files and players, an FM sound library with editor, visual sound-analysis programs, speech-recognition programs and system event monitors.

In addition to being informative, the book is highly readable. After introducing you to Digital Audio Basics, it moves on to editing and effects, audio recording and speech. Separate chapters devoted to three-dimensional sound and sound synthesis immediately follow. Music, Mod players and adding sound to DOS each has a chapter of its own. Chapter 10, Windows Medley, tells you how *Windows* multimedia works, how to use the *Windows* Media Player and how to attach sounds to *Windows* events with the included *Whoop It Up!* program and more. The final chapter, Taking Inventory, gives you tips on locating material in the book and sorting out the included programs, sound files and music.

All in all, this is a well-rounded offering. Its well-illustrated text and jam-packed diskettes make the modest price of this package a steal. If you're into sound on your PC, you can't go wrong with *Sound Effects Playhouse*.

Pentium PCs

Micro Express' MicroFLEX-PCI/Pentium and MicroFLEX-VL/Pentium are two new Pentium-based PCs, one utilizing the PCI bus and the other using the VESA VL bus. The base configurations for both systems include 8M of RAM, a 500M IDE hard-disk drive, 256K of cache RAM, a 14" SVGA video monitor, both 3½" and 5¼" high-density floppy drives, a tower case, a 101-type keyboard, MS-DOS 6.2 and *Windows* 3.1. The

computers are offered with a wide range of options, including multimedia upgrades.

The proprietary motherboards in these computers have eight expansion slots, which include five 16-bit and either three VL or three PCI slots. Up to 128M of RAM is supported on the motherboard. The systems use the AMI BIOS, with FLASH BIOS included on the PCI machine and standard socketed BIOS on the VL machine. $3,250/ $3,250, VL/ PCI. *Micro Express, 1801 Carnegie Ave., Santa Ana, CA 92705; tel.: 714-852-1400; fax: 714-852-1225.*

CIRCLE NO7 ON FREE CARD

PCMCIA Drive

CARDrive from Acma Computers allows an IBM AT or compatible PC to read and write all types of PCMCIA cards, as well as PCMCIA hard drives. It can accept dual cards of Type II and Type III, or a combination of Type I and

Type II, as well as a single Type IV. CARDrive conforms to both the PCMCIA 2.0/ JEIDA 4.1 and Intel ExCa 1.50 standards.

CARDrive consists of one 16-bit AT-bus half-length controller card, two 50-pin interconnect cables and an internal card drive unit that fits into any 3½" or 5¼" disk drive bay. $199. *Acma Computers, Inc., 47988 Fremont Blvd., Fremont, CA 94538; tel.: 510-623-1212; fax: 510-623-0818.*

CIRCLE NO 8 ON FREE CARD

Electricity Saver

B&B Electronics' Green Keeper automatically turns off computer video monitors to reduce electric-power consumption. It connects in series with the keyboard of any IBM/com-

patible PC, and the PC monitor plugs into Green Keeper's ac outlet. Included software for DOS or *Windows* communicates with Green Keeper to turn off the monitor after a user-specified period of inactivity. A touch of a key on the keyboard or the mouse instantly restores power to the monitor. The CPU isn't affected. $69.95. *B&B Electronics, 4000 Baker Rd., PO Box 1040, Ottawa, IL 61350; tel.: 815-434-0846; fax: 815-434-7094.*

CIRCLE NO 9 ON FREE CARD

LaserJet Enhancer

XLI's PhotoJet MIO is an enhancement card that plugs into the MIO slot of an HP LaserJet 4 and 4M. It prints images with 256 gray levels at a resolution equivalent to 2,400 dpi. $749. *XLI Corp., 800 W. Cum-*

mings Park, Ste. 6650, Woburn, MA 01801; tel.: 617-932-9199; fax: 617-932-3449.

CIRCLE NO10 ON FREE CARD

High-Performance Video Monitor

Nissei Sangyo America's Super 17S 17" high performance monitor offers 0.26-mm dot pitch, 1,280 x 1,024 noninterlaced resolution and an advanced flat, square anti-glare CRT. It meets the EPA's Energy Star and Sweden's MPR II guidelines and conforms to a wide range of standards. $900. *Nissei Sangyo America, Ltd., 100 Lowder Brook Dr., Ste. 2400, Westwood, MA 02090; tel.: 617-461-8300.*

CIRCLE NO 11 ON FREE CARD

Microprocessor-Controlled UPS

The Models UPS-400, UPS-600 and UPS-800 are microprocessor controlled backup systems from Optiquest. The model number represents the UPS's capacity in volt-amps. Each model has a typical transfer time of 2 ms with a pure sine-wave output. The systems also protect against power sags by providing automatic voltage regulation that boosts line voltage by 12%.

Each UPS performs a self-diagnosis every time the system is turned on, and it incorporates a test switch to determine if the system is working properly. A LED display tells you when the battery is low, when and how it is in use and if a power sag occurs. Additional features include automatic cut-off, restart and external cut-off. A remote interface DB-9 connector port for Novell and Unix is provided on the rear panel of all models. $249/$299/$399, 400/600/800. *Optiquest, Inc., 20490 E. Business Pkwy., Walnut, CA 91789; tel.: 909-468-3750; fax: 909-468-3770.*

CIRCLE NO 12 ON FREE CARD

Fan I/O Card

The FanCard/Combo from T.S. Micro Tech is a super I/O card that contains two bidirectional fans. Besides the fans, which are used to cool the PC, the card includes two serial ports, one parallel printer port, one game port, an IDE hard-disk controller that handles dual hard drives and a floppy-disk controller for two floppy drives. Additionally, the card has a dc output for 6- or 9-volt multimedia speakers. $44.95. *T.S. MicroTech, Inc., 20818 Higgins Ct., Torrance, CA 90501; tel.: 800-959-9419.*

CIRCLE NO 13 ON FREE CARD

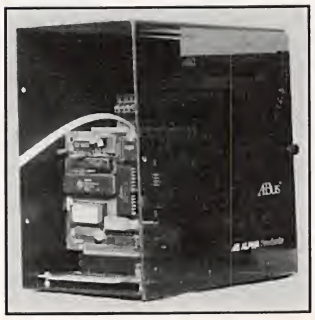
Microcontroller Programmer

Xeltek's SuperPro II PC-based universal programmer supports more than 2,000 microcontroller devices. In addition to microcontrollers, it can be used to program EPROMs with up to 8M capacity, FLASH EPROMs, BPROMs, PALs and GALs. It can also be used to test TTL/CMOS memory. Adapters are available for any microcontroller that requires special configurations. Included software provides comprehensive control of various device functions. $599. *Xeltek, 757 N. Pastoria Ave., Sunnyvale, CA 94086; tel.: 408-524-1932; fax: 408-245-7084.*

CIRCLE NO 14 ON FREE CARD

A-Bus Serial Communications

The Model SA-129 Serial Interface from Alpha Products



Innovative Keyboard

Keyboard Kit
Hooleon's Custom Keyboard Kit for the Visually Impaired features high-contrast, large-print keytop legends for a standard 101-key style keyboard in combination with raised Braille characters. The combined legends are applied to durable labels that adhere directly to the top of the keyboard's keys. $21.95. *Hooleon Corp., 260 Justin Dr., Cotton-wood, AZ 86326; tel.: 800-937-1337; fax: 602-634-4620.*

CIRCLE NO. 15 ON FREE CARD

Hinged Keys
The new Hinged Actuator Notebook Keyboard from Brother provides the full 4-mm stroke travel that has become the standard in desktop computing, giving notebook users the familiar feel and comfortable performance of a desktop PC. While keystroke distance is maximized, the notebook keyboard design remains compact at 10 mm in height. The difference in this notebook keyboard is a hinged actuator design that replaces the standard plunger mechanism beneath the key with a pair of actuators set on a rotatable hinge. These actuators provide the full 4 mm stroke not previously available in notebook keyboards with a similar key height.

This new keyboard is currently being featured on the Texas Instruments TravelMate 4000E WinDX2/50 Active Matrix Color Notebook Computer. *Brother Int'l. Corp., OEM Division, 200 Cottontail Lane, Somerset, NJ 08875; tel.: 908-356-8880.*

CIRCLE NO. 16 ON FREE CARD

allows serial communication between any PC and the company's low-cost A-Bus. Each interface supports up to 25 A-Bus application cards. Up to 16 adapters can be daisy-chained in one system, for a maximum of 400 application cards. *Alpha Products, 303 Linwood Ave., Fairfield, CT 06430; tel.: 203-259-8813; fax: 203-254-0169.*

CIRCLE NO 17 ON FREE CARD

16-Bit Stereo Sound Card

Genoa Systems' AudioBlitz Stereo 16+ sound card operates in either eight- or full 16-bit stereo, with sample rates ranging up to 44.1 kHz. The card is MPC2-compliant and compatible with Windows Sound System 2.0, AdLib and Sound Blaster. It also supports three different CD-ROM interfaces, which include Sony, Panasonic and Mitsumi. The standard FM synthesizer includes a Yamaha OPL4, 24-voice and 16-bit waveform data. The card also offers a MIDI interface and built-in stereo 4-watt power amplifiers. Its audio-mixing capabilities include stereo synthesizer, digital audio, CD audio, microphone input and external line-in. Included with the package are two audio-editing application programs, *Sound Impression* and *Recording Session*. Available as an option is a Wave Table Synthesizer daughterboard. $139/$99, AudioBlitz card/Daughterboard. *Genoa Systems, 75 E. Trimble Rd., San Jose, CA 95131; tel.: 408-432-9090; fax: 408-434-0997.*

CIRCLE NO 18 ON FREE CARD

PCMCIA Ethernet

The Apex Ethernet PC Card PCMCIA Type II adapter lets you connect an IBM/compatible notebook computer to any Ethernet network. Consisting of an Ethernet PC card and a LAN connector that goes from the card to the wall, the Ethernet adapter is available in 10Base-T and 10Base-2 models, complies with the IEEE 802.3/Ethernet V2.0 standards and supports most popular notebook computers. Features include eight- or 16-bit data transfer, 128K of FLASH memory and 16K packet buffer and zero-wait-state bus interface in shared-memory mode. $289. *Apex Data, Inc., 6624 Owens Dr., Pleasanton, CA 94588; tel.: 510-416-5656.*

CIRCLE NO 19 ON FREE CARD

VGA Interface

DSP Design's GCAT-4000 VGA controller for CRT and flat-panel displays and a keypad controller for the credit-card-size GCAT- 3000-compatible computer can boot ROM DOS in ROM and measures only 3.4" × 2.6". Its features include support for CRT, mono LCD, color LCD, plasma and electroluminescent displays; support for sever sizes of flat-panel displays; CRT resolution up to 1,024 × 768 with up to 256 colors per pixel; simultaneous CRT and flat panel displays; up to 1M of display RAM; drivers for popular applications; interface to support keypads of up to 24 keys; and software to allow any compatible scan code to be associated with any key. $425/$799 for GCAT-4000/3000. *DSP Design, The Saelig Co., 1193 Moseley Rd., Victor, NY 14564; tel.: 716-425-3753; fax: 716-425-3835.*

CIRCLE NO. 20 ON FREE CARD

Flux-Pen Tool

HMC's Flux-Pen tool can be used for rework or touch-up

soldering. The chisel point shape of the tip lets you work in confined spaces, while a spring valve prevents the flux inside the pen from drying out. The Flux-Pen is available in three formulations: mildly activated rosin, type RMA, low solids, halide free, "no clean" and water soluble, type OA. *HMC, 33 Springdale Ave., Canton, MA 02021; tel.: 617-821-1870; fax: 617- 821-4133.*

CIRCLE NO. 21 ON FREE CARD

RISC Microcontroller Data-Acquisition Board

Robomaster from P.C. Porter Engineering is a 2" x 2" stackable board that contains 16 bidirectional I/O ports and two extra lines for strobing or latching. It uses only four ASCII characters, chip ID from 1 to 255 hex for stacking, O for output and I for input. It's equipped with a nine-pin serial female connector, nulled three-line communication for TX, RX, GND 9,500 or 115K baud,8,n,1 communication.

This board is designed for developers who have PIC 16C55 burners. It's said to be ideal for laptop field applications, robotics and remote modem call-in systems to turn on/off devices or monitor what's going on remotely. $59.95 without PIC 16C55. *P.C. Porter Engineering, PO Box 732, Titusville, FL 32781-0732; tel.: 407-268-4562.*

CIRCLE NO. 22 ON FREE CARD

Digital Controller Board

Blue Earth Research's new Xplor-32 includes an Intel 80C32 CPU, Xicor 8K EEPROM, serial port and 5-volt dc regulator on a board that measures only 2.2" x 2.15". The EEPROM features concurrent read/write technology that allows it to be read from while being written to. A BASIC interpreter occupies the lower half of the block-protect-able EEPROM, leaving the upper

half for BASIC programs and data. Included in the BASIC interpreter are such specialized utilities as frequency measurement, real-time clock/calendar and hex file loading. `BASIC programs can be interactively edited, and stored BASIC programs execute automatically upon start-up.

Each of Xplor-32's 12 digital I/O lines include a socket block that provides for solderless connections for interface components. All external connections are made via a single DB-25 connector.

A companion ST-25 interface module provides easy access to all Xplor-32 signals. It has screw-type terminals for all I/O lines and includes a power-supply jack, DB-9 connector for PC/compatible serial ports and X-10 power-line interface jack. $59.95 Xplor-32; $99.95 starter package that includes Xplor-32, ST-25, user's manual, PC serial interface cable, 9-volt power supply and applications diskette. *Blue Earth Research, 165 W. Lind Ct., Mankato, MN 56001; tel.: 507-387-4001; fax: 507-387-4008.*

CIRCLE NO.23 ON FREE CARD

PIC16C71/ PIC16C84 Programmer/ Downloader

TrueFlight from Parallax is a programmer for the PIC16C71 and PIC16C84 microcontrollers that, with the addition of a ribbon cable and UV eraser, can also serve as a downloader. Its 18-pin LIF socket can hold a PIC16C71 or PIC16C84 and has duplicate pins on the end of an 18-pin cable that can you can plug in place of a PIC in your target system. With the cable plugged in, you essentially have a PIC plugged into the target. This is done with a relay to make operation transparent.

The UV eraser snugly fits over the LIF socket, completely covering the PIC. When TrueFlight attempts to program a part, it first checks to see if the part is erased. If not, it turns on the eraser and periodically checks the PIC. When the PIC is fully erased, TrueFlight continues with programming. For electrically-erasable PIC16C84s, no UV erasure is required.

Typical system time to erase and program a PIC16C71 is about 65 seconds. Cycle time for the PIC16C84 is only 9 seconds. $299. *Parallax, 3805 Atherton Rd., #102, Rocklin, CA 95765; tel.: 916-624-8333; fax: 916-624-8003; BBS: 916-624-7101.*

CIRCLE NO. 24 ON FREE CARD

Software

Internet Interface

WinGopher Complete Systems desktop graphical interface from NOTIS gives PC users everything they need to connect to and navigate within the Internet. The software is a Microsoft *Windows*-based front end to Gopher, the University of Minnesota's Internet protocol product. *WinGopher Complete* supports Archie, VERONICA and WAIS searching, as well as binary and character file transfer. The program also contains a Telnet application to reach Internet sites that don't currently support the Gopher protocol. $129. *NOTIS Systems, Inc., 1007 Church St., Evanston, IL 60201; tel.: 708-866-0150; fax: 708-866-0178.*

CIRCLE NO 25 ON FREE CARD

VoiceMouse for *Windows*

Interactive Products' *VoiceMouse*, a voice recognition

Understanding Small Microcontrollers

By James M. Sibigtroth
(PTR Prentice Hall. Soft cover. 295 pages. $35.)

This is a Motorola book produced and marketed by Prentice Hall. It focuses on Motorola's M68HC05 microprocessor family. The first part of the textbook reviews all the basics, up through computer numbers and codes to gates, buffers, memory, CPU and computer architecture. The author then directs his writing to the subject Motorola CPU, presenting its instruction set, showing how to prepare a set of instructions and application demonstrations. Bolstered by reference tables and a glossary, it's a worthy book for anyone who wants to start working with small microcontrollers that use this chip.

The Hands-On Guide to Network Management

By John Mueller & Robert A. Williams (Windcrest/McGraw Hill. Soft cover. 368 pages. $26.95.)

This is a real-world book for network managers, explaining how to solve a variety of networking problems they may face. In other words, it's a survival guide. Although focusing more on Novell networks, which is the most popular one, it also covers a bevy of others, such as NetWare and LANtastic. The text is sufficiently broad, however, to enable readers to transfer what's learned to other LANs. The authors don't look upon the network manager as the single person to handle everything. They include, strongly, the roles of others who are involved in using LANs, from user to applications developer. In practice, this coordination is the way it really works. A wealth of LAN information is presented, supplemented by plenty of illustrations—screen shots and report forms.

Among this book's contents is creating a menu system, dealing with different operating systems, including such multitasking software as *Windows*, OS/2 and *DESQview*, where fixing problem setups and tuning the environment are addressed. Other chapters include tuning up applications, such as *WordPerfect*, Lotus *1-2-3*, and others; choosing an application developer and coordinating re- sources; creating a problem report system; backing up a file server and network security; network documentation; network management; software aids; and recovering from catastrophes.

In all, this is a fine book for network managers. Everyone in this field should get a copy and read it thoroughly.

DDC Quick Reference Guide for MS-DOS 6

By Karl Schwartz
(Dictation Disc Company. Spiral-bound. 228 pages. $8.95.)

Quick reference guides abound in the computer-book market. The MS-DOS 6 one here is the latest one published by DCC. Like others, it covers directions for using a program or disk operating system in a reference-book-like manner. This approach is a real time-saver as compared to searching through a manual. Unlike, say, IBM's documentation, you don't have to guess what the author is saying, as in confusing xx and dd and what-have-you codes. The DDC presentations are particularly clear. In easy-step format, you're told just what keys to press in bold reverse type blocks. You just can't make a mistake or wonder if you're doing it wrong. Helpful appendices for this guide include key commands, common error messages and customizing, among other helpful pointers. It's the best of the quick-reference pack of books to date.

software package for *Windows*, provides "command and control" via voice for all popular software applications. The software operates as a speaker-dependent word or short-phrase isolated system. Only one training pass per command is required.

VoiceMouse is claimed to have unlimited vocabulary size and to ignore background noise and unfamiliar words. The package operates with all popular eight- and 16-bit sound cards and requires a microphone. $79.95. *Interactive Products, Inc., 1600 Valley River Dr., Ste. 170, Eugene, OR 97401; tel.: 503-341-4964; fax: 503-341-4965.*

CIRCLE NO26 ON FREE CARD

Controller Compiler

Blue Earth Research's *BEC51* BASIC compiler is claimed to be 100% compatible with Blue Earth BASIC. The compiler can be used with BASIC programs developed for any of the

Blue Earth Micro programmable controllers with a resident Blue Earth BASIC interpreter. Features include the ability to program BASIC without line numbers, dynamic length string variables, program-debugging commands and buffered serial I/O. BEC51 supports most members of the MCS-51 family. $295. *Blue Earth Research, 165 W. Lind Ct., Mankato, MN 56001; tel.: 507-387-4001; fax: 507-387-4008.*

CIRCLE NO 27 ON FREE CARD

Windows Scientist

Scientist for Microsoft *Windows* from MicroMath is a software package dedicated exclusively to experimental data-fitting and -simulation. The program includes a math worksheet/notebook that supports 100 functions and more than 500 dimensional units. No programming is required. Model equations are entered in an intuitive syntax that's familiar to researchers. $295. *MicroMath Scientific Software, 2469 E. Ft. Union Blvd., PO Box 21550, Salt Lake City, UT 84121; tel.: 801-943-0290; fax: 801-943-0299.*

CIRCLE NO 28 ON FREE CARD

Sound Utilities

MCS SoundSavers and *MCS SoundRevue* are two new sound utilities from Animotion Development. *MCS SoundSavers* is a collection of screen-saver modules that respond visually to audio input from multiple sources. All modules let you select from three input options: simulated audio, recording input and wave playback.

MCS Sound Revue, shipped on CD ROM, contains a library of 300 sound effects in all popular .WAV sample rates, including 11, 22 and 44 kHz. Bundled with the product are editing tools needed to customize sound files and integrate a user's own custom audio clips into a variety of applications. $39.95/$49.95, *Savers/Revue. Animotion Development Corp., 3720 Fourth Ave. S., Ste. 205, Birmingham, AL 35222; tel.: 205-591-5715; fax: 205-591-5716.*

CIRCLE NO 29 ON FREE CARD

Label Writer for *Windows*

CoStar's LabelWriter II is a hardware/software combo that plugs into the serial port of a PC. The new LabelWriter II *Windows* software encompasses three components: A full-featured application appears as a Tool Bar to design label templates, manage mailing lists, print address labels and other things. A *Windows* print driver is included for label printing directly from any *Windows* program. Macros appear as icons for access within the Tool Bars for three popular word processing programs—*WordPerfect for Windows*, *Word for Windows* and *Ami Pro*. $249.95. *CoStar Corp., 100 Field Point Rd., Greenwich, CT 06830; tel.: 203-661-9700; fax: 203-661-1540.*

CIRCLE NO 30 ON FREE CARD

Disk-Drive Utility

Disk Manager 6.0 from Ontrack Computer Systems is a hard-disk installation utility that supports up to 8G in capacity with 2G per partition. It also has a dynamic drive overlay that lets you install an IDE drive with a capacity in excess of 528M as a single bootable partition. Additionally, *Disk Manager* bypasses the 528M BIOS limitation and lets you access the drive's full capacity on drives with greater-than-540M capacity.

For the novice user, *Disk Manager* contains a Fast Preparation option that completely installs IDE and SCSI drives in less than a minute. $124.95. *Ontrack Computer Systems, 6321 Bury Dr., Eden Prairie, MN 55346; tel.: 612-937-1107; fax: 714-263-9246.*

CIRCLE NO 31 ON FREE CARD

TangoPRO Upgrade

Version 2.2 of Accel Technologies *TangoPRO for Windows*, a schematic-entry and PCB-layout tool, now offers pin and gate swapping, .DXF input and output and significantly improved response times for screen redraw, move and undo functions. The new version also has a reduced price and its hardware security device removed.

Version 2.2 consists of *TangoPRO Schematic*, *TangoPRO PCB* and *TangoPRO Route*, which can be purchased separately, or together for a cost savings of $500. *TangoPRO Lite* is a reduced-function version of *TangoPRO* available for designers who have less-complex design needs. $995/$5,950/$5,500/$1,995, *Schematic/PCB/Route/Lite. Accel Technologies, Inc., 6825 Flanders Dr., San Diego, CA 92121; tel.: 619-554-1000; fax: 619-554-1019.*

CIRCLE NO 32 ON FREE CARD

2D CAD

IBM CAD's *CAD/3X* is a 2D CAD package with facilities for the graphics artist. It features 2D Boolean operations, boundary trim, engineering analysis, true associative dimensioning and .DXF import and export. Additionally, the program offers solid area fills, more than 50 text fonts, unlimited hatching, simple import and export of ASCII text and .CGM and encapsulated PostScript (.EPS) output to word processors and publishing software. The software requires only 1M of RAM. $495. *IBM CAD, PO Box 18375, Boulder, CO 80308; tel.: 800-IBM CAD-1; fax: 303-444-3594.*

CIRCLE NO 33 ON FREE CARD

Low-Cost *Windows* CAD

The latest version of *Gamma-CAD Pro* from Gamma Software has several new features, including .DXF file transfer, dimensioning commands and more than 100 drawing symbols. This release also lets you copy a drawing into the *Windows* Clipboard as a bitmap for pasting into other applications. $25. *Gamma Software, PO Box 8191, Ft. Collins, CO 80526; tel.: 303-490-2928.*

CIRCLE NO 34 ON FREE CARD

Multimedia Authoring Tool

Q/Media for Windows Release 2.0 from Q/Media Software is the latest release of this entry-level multimedia authoring tool. New integration capabilities include OLE 2.0, flexible interactivity with branching, an integrated outliner, automated bulleting of text and templates. Other new features include predefined styles for

(Continued on page 107)

By Steve Montgomery

Building Robot Power Systems

Presented here are important details for properly designing and building portable power systems for robotic and other uses

If you design robots, you already know that a robot's power system is its weakest link, mostly due to the fact that it relies upon a battery for its energy. As a matter of fact, any project that runs on portable power falls prey to the same limitations. Since portable power is crucial to successful robotics, this article looks at the common battery technologies and discusses how they can be incorporated into a robot power system. My primary focus is on using the lead-acid battery for deep-cycle loads, such as drive motors, and Ni-Cd batteries for logic and computer loads.

I'll discuss how each type of battery works, how to monitor energy level and how to recharge it when its energy drops below a usable level. Since future articles on robot design will reference the material presented here, be sure to keep this issue for reference purposes. Keep in mind that although this material is written for robot design, the engineering principles set forth should be employed in the design of *any* battery power system.

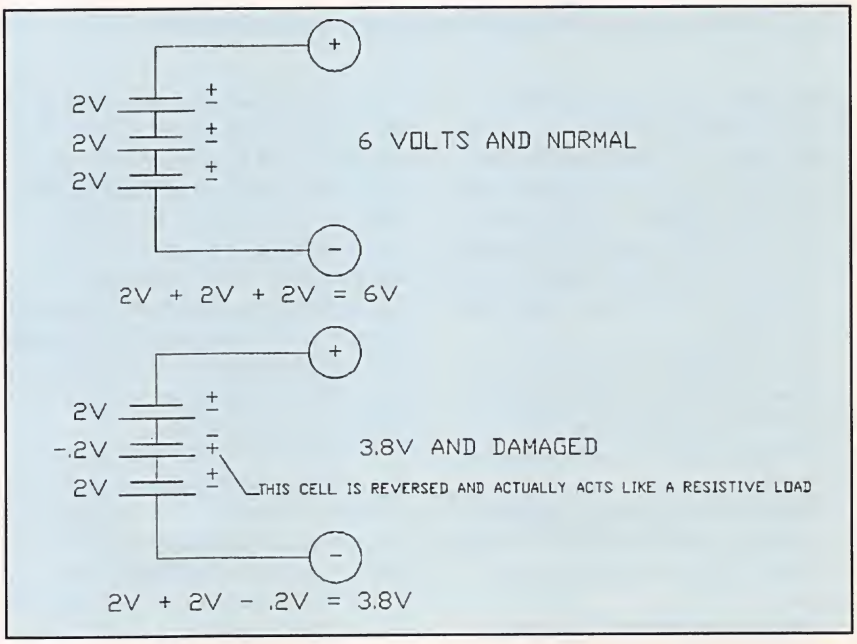


Fig. 1. Cell reversal explained. In upper diagram three 2-volt cells are connected in series to make up a nominal 6-volt battery, output of which is equal to sum of voltages of cells, or 2 volts + 2 volts + 2 volts = 6 volts. In lower drawing, center cell has reversed to point where it has a negative potential of 0.2 volt and actually acts as a resistor with a 0.2-volt drop across it. Now total battery voltage output is drastically reduced: to an unusable 2 volts + 2 volts + –0.2 volt, or 3.8 volts.

Battery Characteristics

All batteries share certain fundamental characteristics. Among the most important of which are voltage delivered at their terminals and ampere-hour rating, which is the measure of power a battery can deliver. Let's look at each of these in detail.

• **Voltage.** A battery's voltage is determined by the voltage per cell (which, in turn, is determined by the battery's chemistry) and the number of cells it contains. All batteries are internally configured with their cells in series. There's a problem with this configuration that can result in poor battery performance if you don't properly design the power supply circuitry. This problem arises when one cell is discharged to the point where it no longer supplies current and becomes a load on the other cells. This condition, called "cell reversal," is explained in Fig. 1. The upper diagram shows three 2-volt cells connected in series to make up a nominal 6-volt battery. Output voltage of this battery is equal to the sum of the voltages of the cells, or 2 volts + 2 volts + 2 volts = 6 volts.

In the lower drawing, the center cell has reversed to the point where it has a negative potential of 0.2 volt. In this case, the cell actually acts as a resistor with a 0.2-volt drop across it, meaning that the other two cells are providing enough current to the reversed cell to create a 2-volt drop. Since this cell is negative, total battery voltage output is drastically reduced. Summing the voltages of the individual cells, you can readily see that the battery's output drops to an unusable 2 volts + 2 volts + –0.2 volt, which is 3.8 volts.

Cell reversal is caused when the battery is discharged too much. The

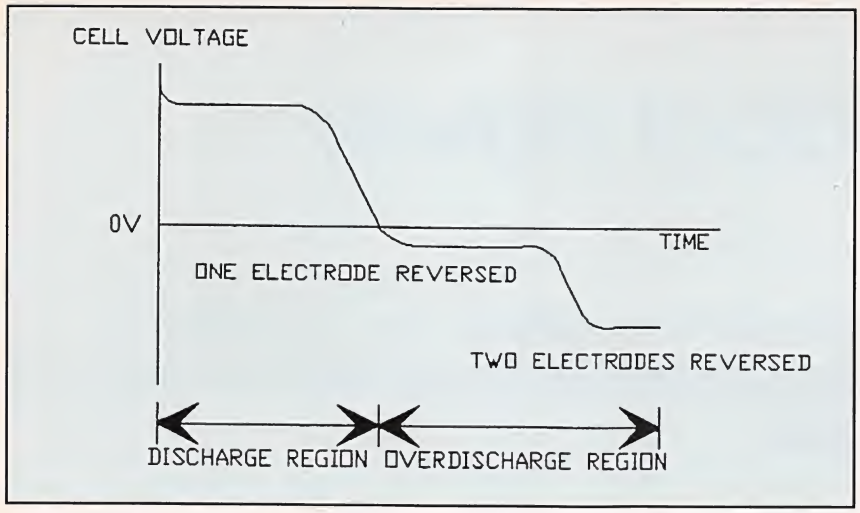


Fig. 2. Graph of typical discharge characteristic of a Ni-Cd battery.

typical discharge graph of a Ni-Cd battery is shown in Fig. 2. Notice that in the normal discharge region, the battery behaves as you'd expect a Ni-Cd battery to behave. It maintains its voltage until the end and then sharply drops off. If at this point the discharge is maintained, the battery will go into cell reversal.

In the over-discharge region, the cell begins to reverse. First, one electrode reverses. More-severe discharge will cause the other electrode to reverse.

The easiest way to prevent cell reversal is to cut off current draw before a battery enters the over-discharge region.

• **Ampere-Hour Rating.** This rating tells how much current can be drawn from the battery and for how long. Batteries provide an ampere-hour, or AH, rating based on a specific time of discharge. For example, a battery may be rated at 5 AH over a 5-hour discharge rate, which means that if this battery were to be discharged at a constant rate of 1 ampere, it would last five hours. This discharge rate is the nominal rate of discharge (also annotated as C). Discharging at a slower rate would increase the life of the battery, and discharging at a higher rate would decrease its life.

As current flows through the battery, internal heat is generated due to I^2R losses resulting from internal resistance R_{int} of the battery. As more heat is produced, the battery becomes less efficient and its power ratings degrade. For this reason, you can say that the AH rating isn't linear across the entire range of discharge rates.

If a battery can last for five hours at a current draw of 1 ampere, it wouldn't be able to last for 2.5 hours at a current draw of 2 amperes. At 2 amperes, internal losses due to heat have increased by a factor of four. The battery must work harder to provide the 2 amperes of current and, therefore, will last a shorter time. On the other hand, if this same battery were to be discharged at a rate of 500 mA, it would last longer than 10 hours because internal losses have decreased by a factor of 4. So, to choose the power AH rating of the battery, you must have an idea of how long you want the battery to last and how much its current draw will be. For example, say your circuitry required 0.5 ampere and you want the battery to last 20 hours. You'd require a battery whose ampere capacity (C) is 10 AH rated at 20 hours.

Table 1. Lead-Acid Vs. Nickel-Cadmium Batteries

	Lead-Acid	Nickel-Cadmium
Anode	Pb	Cd
Cathode	PbO_2	NiOOH
Electrolyte	H_2SO_4	KOH
Cell Voltage		
Nominal	2.0	1.2
End-Of-Charge	1.75	0.9
Advantages	Low Cost Constant Discharge Readily Available Easily Recharged Easily Monitored	Sealed Constant Voltage Readily Available
Drawbacks	Bulky Low Life Cycle	High In Cost Memory Effect Difficult To Recharge Difficult To Monitor

Lead-Acid Vs. Ni-Cd

As I mentioned above, two types of rechargeable batteries are considered in this article: lead-acid and Ni-Cd. Table 1 and Fig. 3 compare these two, the former in tabular form and the latter in graphic form. As illustrated in Fig. 3, the lead-acid battery shows a discharge curve that has a decreasing voltage over the entire range of operation. Because of this, it's easy to detect an impending battery failure and recharge the robot as needed. Several indication levels could be set in the 2.0-to-1.75-volt operating window that would notify the robot of the level of charge of the battery. For instance, a warning could be set at 1.9 volts per cell, with a load-disconnect trip setpoint at 1.8 volts per cell.

The discharge curve of the Ni-Cd battery is very different from that of the lead-acid battery. The former maintains its voltage at a relatively constant level across its entire range of operation. Only at the very end does the Ni-Cd battery's voltage drop off, and does so sharply. Because of this, it's very difficult to monitor the status of the Ni-Cd battery. There exists no indication by the battery's output voltage that its charge is decreasing until the very end. Then, too, it's quite possible that the voltage will drop off faster than the robot can act to recharge the battery. This alone makes Ni-Cd batteries undesirable for motor power. At the high rates of cur-

rent motors draw, the output voltage would drop very fast at the end of the battery's life.

Because of its power capability, price and discharge profile, the lead-acid Battery is the logical choice for motor power. Computer power, though, would benefit from the characteristics of the Ni-Cd battery because its output voltage remains fairly constant until the terminal point. This is advantageous because computer circuits are very sensitive to changes in voltage, requiring the stable voltage supply for proper operation. Computer circuits also typically draw much less current than the motors, allowing more time to detect the voltage drop.

Look again at Fig. 3. Notice that the graphs show voltage decreasing as the battery is discharged. This obvious relationship provides an easy way to monitor battery charge. You can simply look at the battery's output voltage, and once it reaches a certain level and remains there for a time, initiate action to recharge the battery.

Although manufacturers state that a lead-acid cell has a nominal output of 2 volts and an end of useful charge of 1.75 volts, I've found that a lead-acid battery can be depleted to 80% of its nominal charge, or 1.6 volts per cell, before it absolutely needs to be recharged. This is important because the voltage-monitoring circuitry to be described must detect several states of battery charge between the 2-volt per cell nominal charge and the 1.6-volt per cell end-of-charge point. You can use these different states of charge to tell the robot's computer battery status and the urgency in getting it recharged.

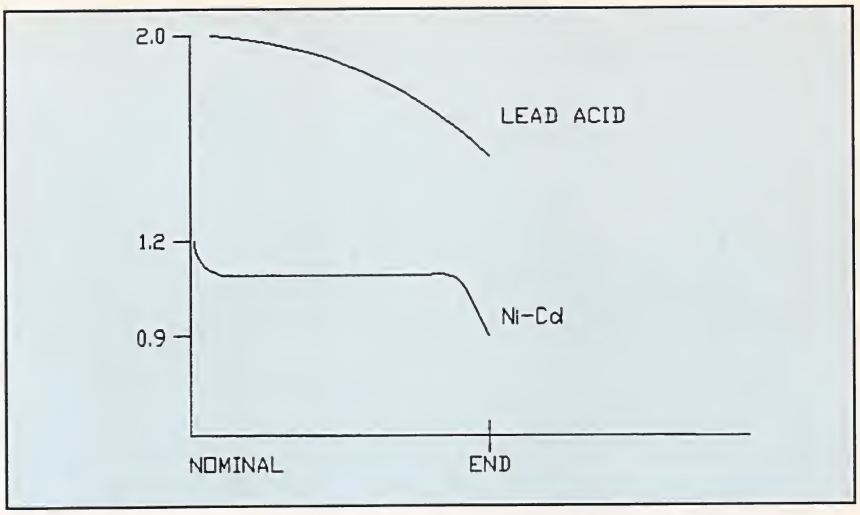


Fig. 3. This graph plots the differences in output-voltage characteristics for lead-acid and Ni-Cd batteries during their discharge cycles.

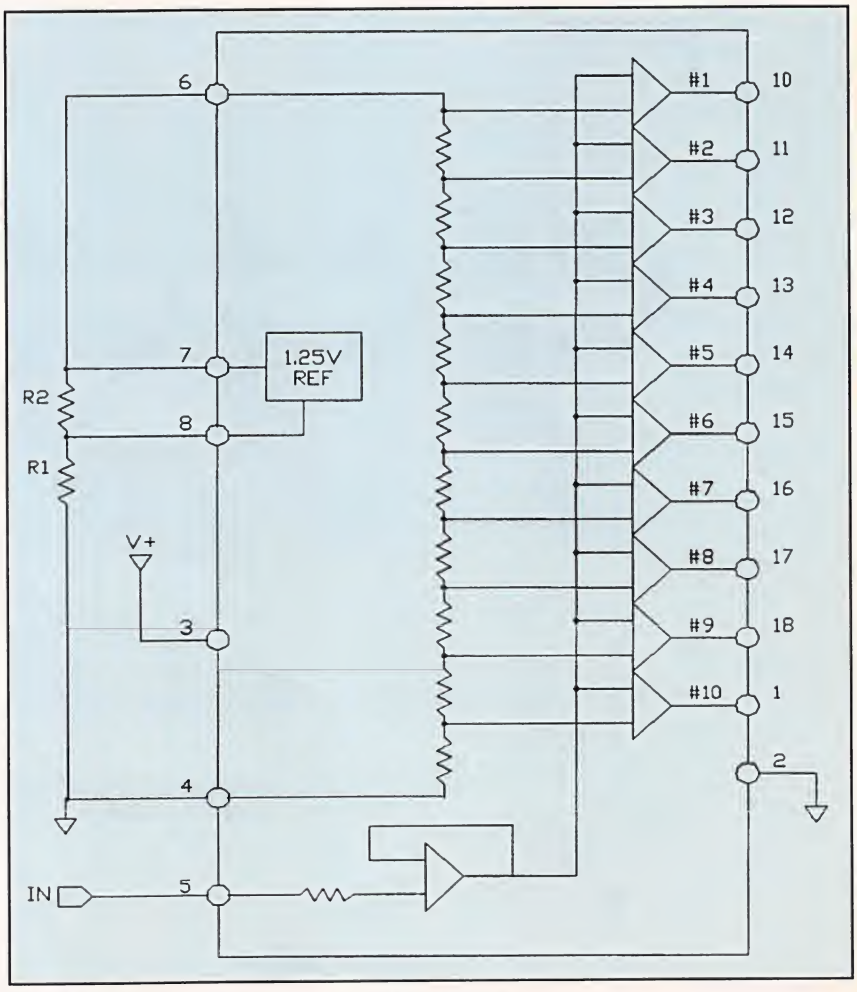


Fig. 4. This is the block diagram of the LM3914.

Battery-Charge Monitors

Multiple levels of battery discharge would provide a robot with the capability of assigning priority to the goal of recharging its batteries and with the ability to monitor the condition of the battery. The robot can monitor the time it takes for the battery to discharge from one level to the next and, therefore, determine if the battery is discharging as expected. If it isn't, the robot would recognize this increased discharge rate as a problem and notify a human that it needs a new battery.

I'll use an LM3914 bargraph driver to build our multi-level battery status monitor. Shown in Fig. 4 is the block diagram of the LM3914, which provides 10 outputs that are capable of driving LED or LCD segments that sequentially turn on as the voltage at pin 5 increases. Ten internal operational amplifiers serve as comparator. A voltage is fed to each of the comparators at their inverting (–) inputs.

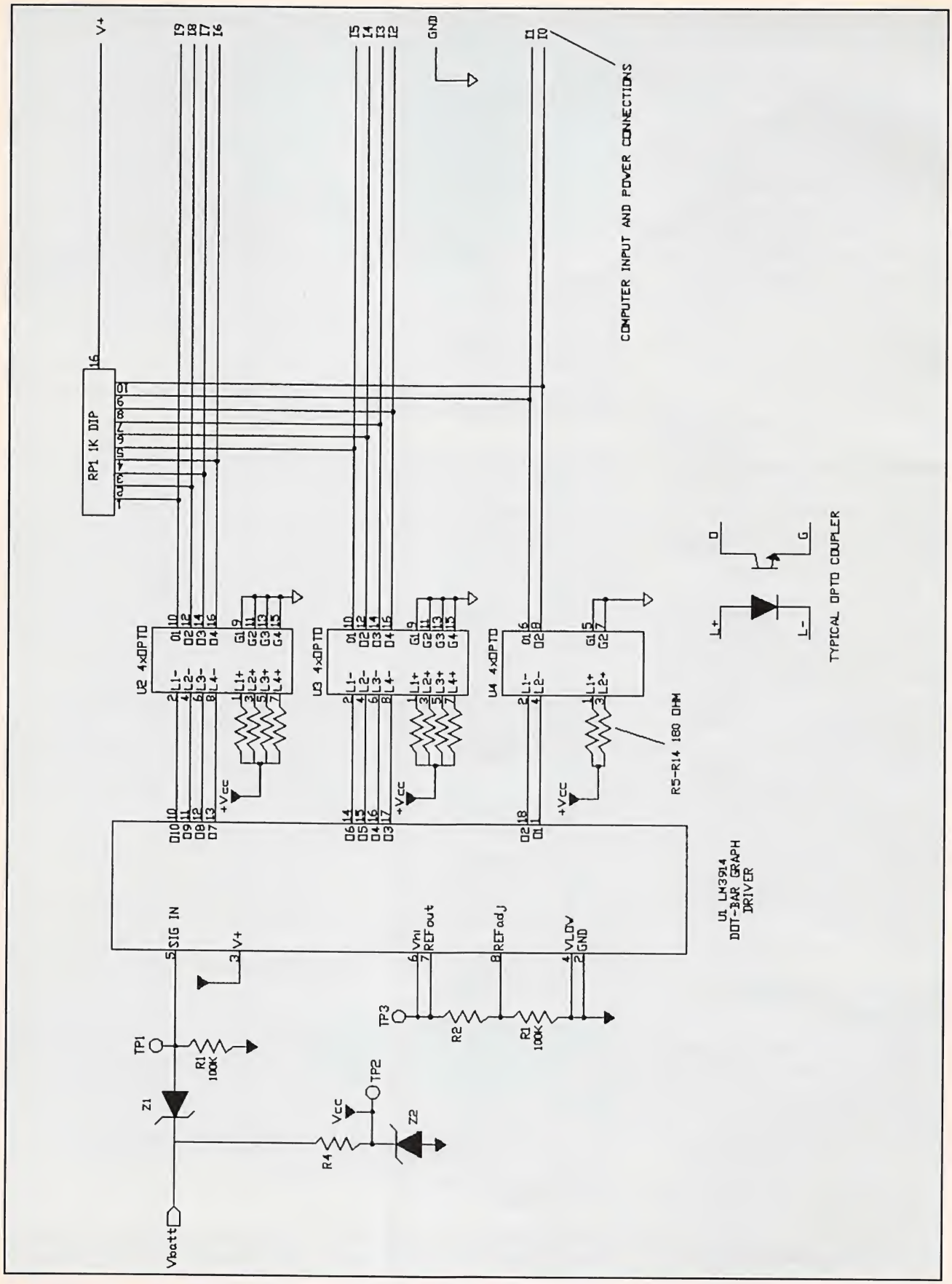


Fig. 5. Complete schematic diagram for a multi-level battery charge monitor built around an LM3914 operated in DOT mode so that only one output is on at any given time.

PARTS LIST

Semiconductors
U1—LM3914
U2,U3—Quad optical-isolator pack
U4—Dual optical-isolator pack
Z1—1N4732 (6-volt) or 1N4739A (12-volt) zener diode
Z2—1N4728A zener diode
Resistors (1/4-watt, 5% tolerance)
R1—100,000 ohms
R2—100,000 ohms (6-volt) or 1,700 ohms (12-volt)
R3—2,200 ohms
R4—80 ohms (6-volt) or 160 ohms (12-volt)
R5 thru R14—180 ohms
RP1—1,000-ohm DIP resistor package
Note: This Parts List gives component values for both 6- and 12-volt circuits. Entries that show a single value or part number indicate that the components are the same for both versions of the circuit.

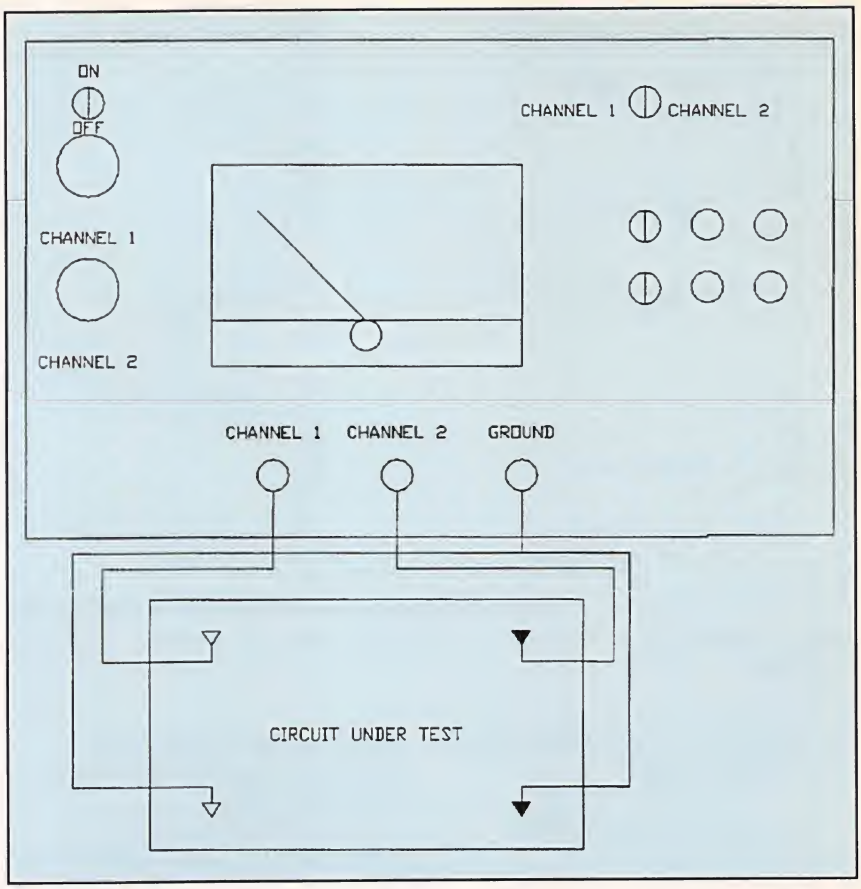


Fig. 6. Connect battery voltage input to Channel 1 of dual-channel power supply, computer power supply input to Channel 2, tie together both grounds and connect them to common on power supply.

The noninverting (+) input for each comparator connects to its respective point in a voltage-divider network that's wired so that the top comparator sees 100% of the reference voltage at pin 6. This voltage determines the scale for the circuit. Therefore, if the reference at pin 6 is 5 volts, the full-scale potential for the circuit is 5 volts.

Each comparator down the line sees 10% less of the full-scale voltage on its + input. Comparator 1 has 5 volts applied to its + input, comparator 2 has 4.5 volts applied to its input, and so on. When 0.5 volt is applied to pin 5, each comparator sees 0.5 volt applied to its – input. Any comparator whose – input voltage is lower than or equal to 0.5 volt switches on.

Once you know that full-scale potential is 5 volts and that each consecutive comparator sees 0.5 volt less than the one before it, you know that the last comparator in the network would see a non-inverting potential of 0.5 volt and, thus, would turn on. Since the next-to-last comparator would see 1 volt, it wouldn't turn on.

As the input increases with the next 0.5-volt step, the next comparator in line switches low. If the chip is in DOT mode, the previous comparator switches high so that only one comparator is on at a time. In this manner, it would look like a dot moving up and down the outputs as the input voltage is varied up and down. In BAR mode, the chip leaves low the previous outputs so that a bargraph is created. This type of display is used in equalizers to generate a graphical effect of sound levels within a frequency band. If your circuit provides only visual indication of the robot's power level, BAR mode is the more appropriate. However, if your circuit inputs to a computer's port, you'll want to operate the circuit in DOT mode.

Shown in Fig. 5 is the complete schematic diagram for a multi-level battery charge monitor. The heart of this circuit is the LM3914, which is operated in DOT mode so that only one output is on at any given time. Scaling for the circuit is set by resistors *R2* and *R3*. To calculate the values of these resistors for both the 6- and 12-volt circuits, use the equation:

$$V_{hi} = 1.25(1 + R3/R2) \qquad \textbf{(Eq. 1)}$$

where V_{hi} is full-scale voltage of the circuit and *R2,* and *3* are the values of scaling resistors.

You must first decide on a value for *R3* and then calculate the value of *R2*. The value of *R3* determines the amount of current the chip can provide to the outputs. Through experimentation, I've found that a value of 2,200 ohms works quite well.

Now, we can rearrange Equation 1 to solve for the value of *R2* as follows:

$$R2 = R3/(V_{hi}/1.25 - 1)$$

where *R3* is 2,200 ohms. V_{hi} is dependent on the battery voltage the circuit is monitoring. If this is 12 volts, the potential on pin 5 when the battery is fully charged is 2.9 volts. It would be 1.2 volts for a 6-volt battery. So, for a 12-volt battery, V_{hi} would be 2.9 volts and *R2* would calculate to:

$$R2 = 2{,}200/(2.9/1.25 - 1)$$
$$R2 = 1{,}700 \text{ ohms}$$

For a 6-volt battery, the calculation isn't quite as easy. V_{hi} in this case is 1.2 volts. When plugged into the equation, this causes the denominator to be negative, yielding *R2* as a negative resistance. Consequently, you can fudge a little and try a value of 100,000

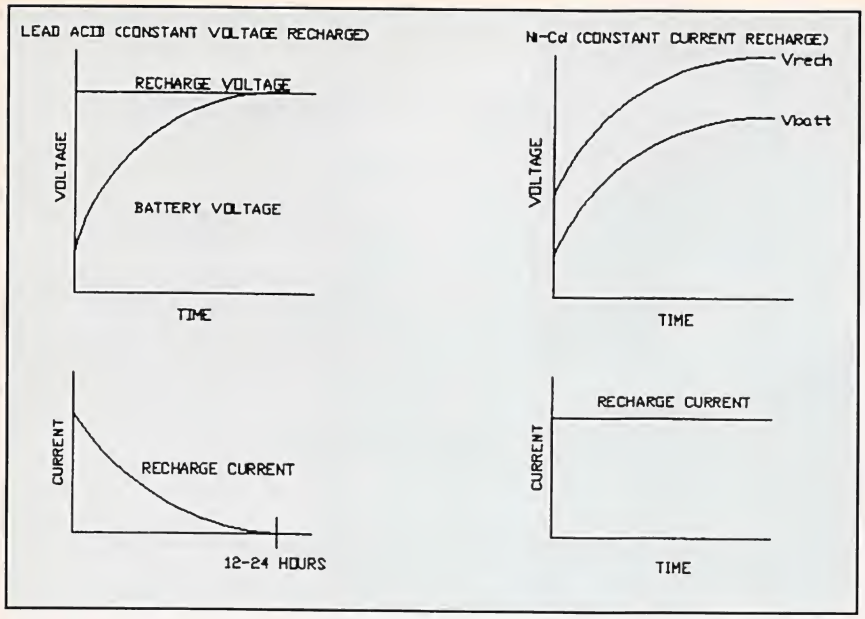


Fig. 7. These graphs describe the recharge cycles for lead-acid and Ni-Cd batteries.

ohms for *R2* and see how this affects your scaling voltage:

$V_{hi} = 1.25\ (1 + 2{,}200/100{,}000)$
$V_{hi} = 1.28$ volts

Thus, V_{hi} would be 1.28 volts versus the desired 1.2 volts. I consider this to be a pretty even trade to keep the circuit simple. *Z1* is used to mask off the battery voltage we don't want to measure, just as in the single bit monitor circuit. It is a 9.1 volt zener diode for monitoring 12 volt batteries, and a 4.7 volt zener for monitoring 6 volt batteries. Resistor *R1* is used to ensure that enough current is being drawn through the zener to make it operate in the zener region.

Resistor *R4* and zener diode *Z2* make up the V_{cc} power supply for the circuit. A V_{cc} of 3.3 volts was chosen to ensure that both the 6- and 12-volt circuits could be accurately monitored down to the lowest battery charge.

Resistor *R4* drops the majority of the voltage and limits the no-load current drawn by *Z2*. Don't omit this resistor because *Z2* will self-destruct without it.

Each of the outputs drives an optical coupler that physically isolates the battery-monitoring circuit from the computer circuit to eliminate interference problems caused by noise. This precaution is taken mostly due to noise generated by the motors. If this circuit is being used to monitor the computer's power supply, you can omit the optical couplers.

Resistors *R5* through *R14* are current limiters for the LEDs in the optical couplers. The output of each optical coupler is open-collector. When the optical coupler is on, this output is tied to ground. When it's off, this output is floating. For this reason, the outputs are brought high by *RP1*.

You can assemble this circuit using simple point-to-point wiring methods. Note that there are two separate grounds. The ground with the solid arrow is the computer's supply ground, and the ground with the open arrow is the monitor circuit's ground. Make

PARTS LIST*

Semiconductors
U1—LM317T
U2—4N36
Capacitors
C1,C2—0.1-µF, 36-volt
Resistors
R1—5,000-ohm pc-mount trimmer potentiometer
R2—270 ohms, 1/4-watt, 5% tolerance
R3—100-ohm, five-turn potentiometer
R4—1,000 ohms, 1/4-watt, 10% tolerance
R_b—See text
*This Parts List is common to both 6- and 12-volt circuit configurations.

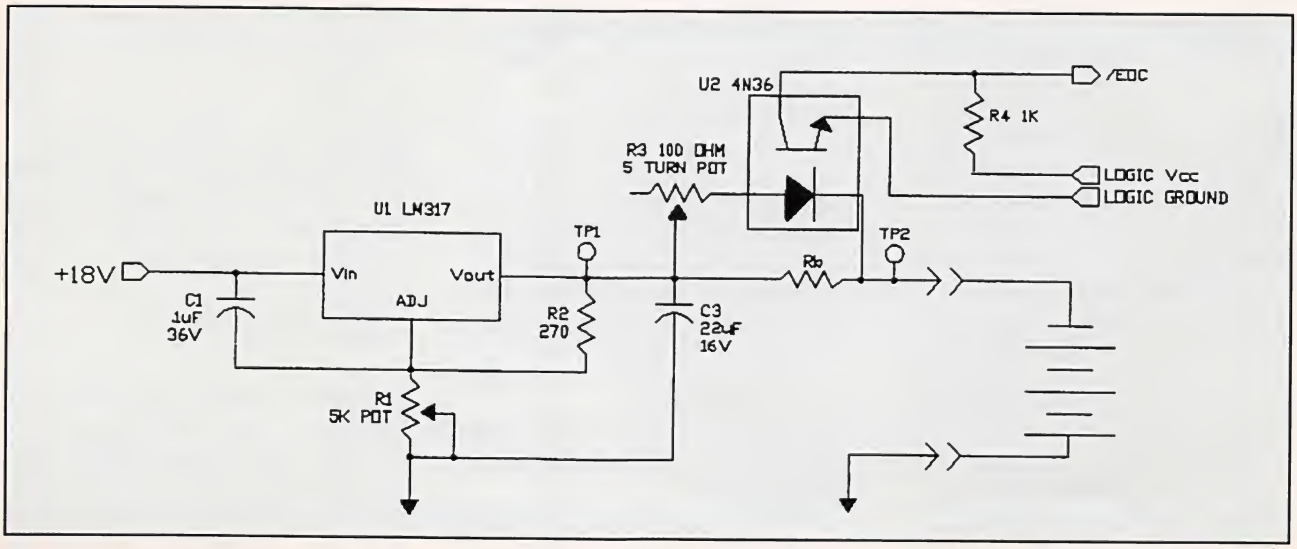


Fig. 8. Schematic diagram of a circuit to recharge a lead-acid battery according to the parameters described in main text.

Introducing a New Era In Technical Training.

World College, an affiliate of the Cleveland Institute of Electronics, was created to provide a four year, independent study, technical degree program to individuals seeking a higher education. The Bachelor of Electronics Engineering Technology Degree, offered by World College, prepares students for high-paying careers in electronics, telecommunications, electrical power, computer and control systems. World College's curriculum is taught in an effective, time-proven, independent study environment. With World College's flexible study schedule, students have the opportunity to work or spend time with their family without having to worry about rigid scheduling residential colleges offer.

A Quality Education with a Flexible Schedule.

In a world heavily dependent on electronic equipment, people who understand electronics will have no problem putting their knowledge to work... in high-paying careers. The staff and faculty of World College have invested over ten years developing, what we believe to be, the finest independent-study, baccalaureate degree program available. World College's mission is to instill in each student the knowledge, *education, and training* that employers are seeking for the many technical positions available today. It's a program created to provide the best education and training possible with a flexible schedule to match your busy lifestyle.

World College is currently seeking approval to confer the Bachelor Degree from the Virginia Council of Higher Education.

Earn A Bachelor of Electronic Engineering Technology Degree from

WORLD COLLEGE

Bringing Technology Home!

Lake Shores Plaza
5193 Shore Drive, Suite 113
Virginia Beach, VA 23455-2500

Send For Your Free Course Catalog.

Take the first step towards a new start in life. Send for World College's Free Independent Course Catalog today and discover how easy and affordable it is to get started on your Bachelor Degree.

World College is affiliated with

ICE

Complete the Entire Degree Program Under One Roof. Yours!

Only World College offers an independent study, four year technical degree which can be completed through one school. All lab equipment*, parts, and software are included in your tuition and the program's 300-plus laboratory experiments can be completed in your own home.

You Pay Only For Time Actually Used.

World College not only provides a means to earn a Bachelor Degree while fulfilling current obligations, but there are no restrictions on how fast you can complete the program. At World College, you pay tuition only for the actual upper-level semesters it takes to graduate. The quicker you complete the program, the less you pay in tuition. It's an effective way to keep you motivated in order to complete the course and move on to a better paying position as quickly as possible.

Currently not available in Ohio.
* Student must have access to a personal computer system.

☐ **YES!** Please send me World College's Free Course Catalog detailing the full curriculum.

Name: _____

Address: _____

Apt: _____

City: _____

State: _____ Zip: _____

Phone: (_____) _____

Age: _____

Return to: WAC006
World College
Lake Shores Plaza
5193 Shore Drive, Suite 113
Virginia Beach, VA 23455-2500

sure to keep these grounds separate.

Since this circuit requires no calibration, there's a pretty simple test procedure you can follow. When you finish wiring the circuit, connect the battery voltage input to Channel 1 of dual-channel power supply and the computer power supply input to Channel 2. Tie together both grounds and connect them to the common on the power supply. Figure 6 is a guide for these connections.

The following procedure is for 12-volt circuits. Use the same procedure for 6-volt circuits, but use the test number in parentheses instead. To test the circuit, you need a dual-channel power supply that can deliver 0 to 15 volts on each channel.

(1) Connect Channel 1 to V_{batt} and Channel 2 to V+.

(2) Set Channel 1 to 12 volts and Channel 2 to 5 volts.

(3) Turn on the power supply.

(4) Check the voltage at TP1 with reference to common. It should be 2.9 (1.2) volts. If you measure no voltage, replace *Z1*. If the measured potential is 12 (6) volts, decrease the value of *R1*.

(5) Check the voltage at TP2. If it isn't 3.3 volts, check *Z2* for heating. If *Z2* is hot, increase the value of *R4*. In either case, replace *Z2*.

(6) Check the voltage at TP3. It should be 2.9 volts. There's no reason why this voltage should be different. If it is, most likely you made a wiring error.

(7) Connect your logic probe's power supply to V+ (computer power supply) and GND. Check the logic levels of I0 through I9. I9 should be low and I0 through I8 should be high. If not, you either have a wiring error or an optical coupler is bad. Find the problem and correct it.

(8) Vary the voltage on Channel 1 of the power supply and watch I0 through I9 to see that they sequentially go low as the voltage is decreased.

Battery Recharging

In this section, I'll discuss the theory behind controlled recharging of a battery and then detail how to build a battery recharging circuit. I'll also discuss how to automate the recharging process by providing feedback to the computer about the status of recharging. Remember that in your robot system, you're going to use lead-acid batteries to drive the motors and Ni-Cd batteries for powering the logic circuitry. Therefore, I'll examine the aspects of recharging each type of battery. When designing a battery-recharge system, you have to take into consideration a few important factors.

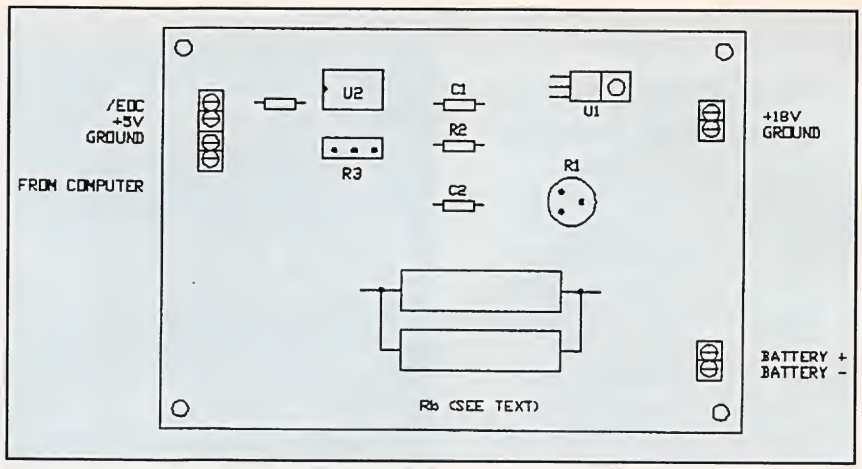


Fig. 9. This is an example of how you might lay out the components on perforated board that has holes on 0.1" centers when building the Fig. 8 circuit.

Rate of recharging is the most important consideration. For gel-cell and lead-acid batteries, a good rule of thumb is 1/10 of the ampere-hour capacity. Thus, a 5-AH battery would be recharged at a maximum rate of 500 mA. You can exceed this recharge rate by up to 200% for quick recharges in emergency situations—at a price. Rapid recharging causes the plates to become warped so that after a few times of being recharged in this manner, the battery will no longer be any good and will have to be replaced.

Ni-Cd batteries have three recharging modes that are supported by most major brands today: standard, quick and fast.

Standard mode of recharging has the same parameters as lead-acid batteries. In this mode, the battery is recharged at 1/10 the rated discharge current and requires about 20 hours for a complete recharge. Since charging is not 100% efficient, it may actually take 36 to 48 hours to recharge to full capacity.

In Quick mode, the batteries are recharged at 1/3 their rated discharge rate. Quick charging can be completed in about 4 to 5 hours. Most batteries can sustain an overcharge at this rate for several hours. Thus, there's no need for trickle charging or charge shut-off. Fast charging permits a battery to be recharged at a rate up to twice its rated discharge rate. In this mode, the battery charging cycle is complete in about 1/2 to 2 hours. Also in this mode, the charger must be shut off at the end of the charging cycle to prevent oxygen venting. Obviously, then, the two types of batteries would be recharged in different ways.

Lead-acid batteries will be recharged at a constant voltage, usually 2.4 volts per cell. Based on the worst-case battery voltage, a ballast resistor is included in the circuit to limit the maximum recharge current to 1/10 the rated discharge current. Fast charges can be performed at up to the rated discharge current.

Ni-Cd batteries won't be recharged with a constant voltage. Instead, they're recharged with a constant current. The current maintained by the recharging circuit depends on the recharge mode used to provide power to the circuit. Recharger voltage increases as battery voltage increases to maintain a constant battery current draw. When the voltage output of the recharger reaches the desired battery voltage plus 1 volt (to provide a small amount of overcharging), the computer is notified and the recharger is turned off.

Recharger Project

Most manufacturers of lead-acid batteries recommend a constant recharge potential of 2.4 volts per cell and a limited recharge rate of 10% of rated discharge current. From this, we can infer that the recharge circuit for a lead-acid battery must provide a con-

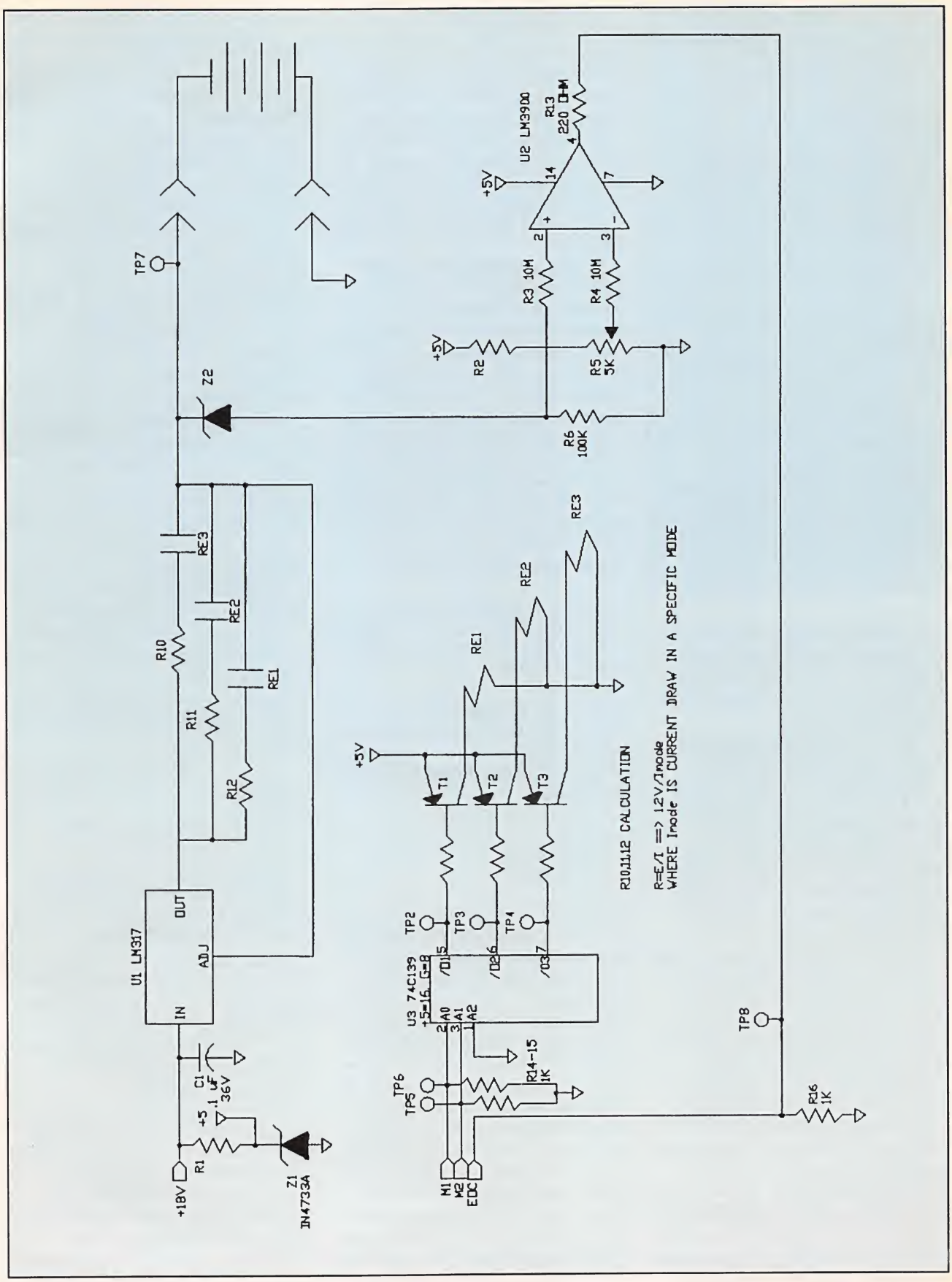


Fig. 10. Portable-power circuit details for robotic applications. Same circuitry can be used for other applications that require battery power.

PARTS LIST

Semiconductors
T1,T2,T3—2N3906 transistor
U1—LM317T
U2—LM3900
U3—74C139
Z1—1N4733A zener diode
Z2—1N4732A (6-volt) or 1N4739A (12-volt) zener diode
Capacitors
C1—0.1-µF, 36-volt
Resistors
R1—60 ohms (6-volt) or 120 ohms (12-volt)
R2—23,300 ohms (6-volt) or 1,000 ohms (12-volt)
R3,R4—10 megohms
R5—5,000-ohm potentiometer
R6—100,000 ohms
R7,R8,R9—1,000 ohms
R10,R11,R12—See text
R13—220 ohms
R14,R15—1,000 ohms
Note: This Parts List gives component values for both 6- and 12-volt circuits. Entries that show a single value or part number indicate that the components are the same for both versions of the circuit.

stant, regulated voltage to the battery throughout the recharging cycle. Furthermore, we know that current that the battery draws during the recharge cycle must be limited.

Figure 7 describes the battery-recharge cycle. Initially, the battery voltage is depleted to some value, referred to as V_{min}. A constant recharge voltage is applied to the battery (V_{rech}). At this point, the battery is pulling the maximum current from the recharging circuit (I_{max}). It's at this point that you must limit current to 10% of the discharge.

As time goes by, the battery voltage will begin increasing. When this occurs, the difference between the battery and recharger voltages will decrease, causing the current to decrease to near zero at the end of charge.

Shown in Fig. 8 is the schematic diagram of a circuit that recharges a lead-acid battery according to the parameters described above. Adjustable regulator *U1* maintains a 1.25-volt differential between the ADJ and V_{out} terminals. Resistors *R1* and *R2* form a voltage-divider feedback network that permits V_{out} to be adjusted by varying the voltage on the ADJ terminal. Resistor *R1* sets the output voltage.

The voltage regulator is good for 1 ampere of continuous current when properly heat sinked. Using this regulator, the circuit can recharge batteries that are rated for up to a 10-ampere discharge rate, which includes most batteries used for mobile robotics.

Capacitor *C1* prevents input ripple rejection. The internal regulation circuitry of the LM317 requires that this measure be taken or it won't regulate. Capacitor *C2* filters the output of the regulator.

The purpose of ballast resistor R_b between the output of the regulator and the battery is to limit the in-rush current to the battery when charging first begins. To determine the value of this resistor, you must know three things: maximum current allowed, recharge voltage and worst-case battery voltage. For example, assume that I_{max} is 500 mA, recharge potential is 14.4 volts and worst-case battery potential is 8 volts. The value of R_b would have to drop 6.4 volts (14.4 – 8) at a 500-mA current draw. You can use ohm's law to calculate this as follows:

$$E(volts) = I(amperes) \times R_b(ohms)$$
$$R_b = (V_{rech} - V_{batt})/I_{max} \quad \textbf{(Eq. 2)}$$
$$R_b = (14.4 \text{ volts} - 8 \text{ volts})/0.5 \text{ amperes}$$
$$R_b = 12.8 \text{ ohms}$$

In this case, R_b would have to be 12.8 ohms. Using the power equation, you can calculate how many watts it needs to be rated for to completely specify the resistor:

$$P = I^2R_b$$
$$P = 0.5^2 \times 12.8$$
$$P = 3.2 \text{ watts}$$

It may be a bit difficult to find a 12.8-ohm, 3.2-watt resistor. An easier solution would be to parallel a couple of resistors to make the required value. For instance, parallel two 25-ohm, 2-watt resistors to get an equivalent resistor rated at 12.5 ohms and 4 watts, which is close enough for this circuit. The remaining piece of the circuit is used as a feedback to the computer. It tells the computer when the recharging cycle is completed. The feedback circuit is made up of a simple optical coupler and dropping resistor and is connected across the ballast resistor. The ballast resistor limits the in-rush current to the battery. Therefore, the voltage drop across it would be proportional to current. Your goal is to detect the end-of-charge current where the battery is drawing very little current and, hence, battery voltage is at its nominal value. So, you use the potential across the resistor to power the LED in the optical coupler. When the differential voltage drops to less than a certain threshold, set by *R3*, the LED turns off and the computer is notified that the recharging cycle is completed. Resistor *R4* pulls up the open-collector output of the optical coupler. To determine the value of *R3*, you must know the voltage dropped across R_b where you want the LED to turn off. For instance, a 12-volt battery is considered fully charged at 12.0 volts. Since the voltage regulator's output is 14.4 volts, the voltage dropped across R_b at the end of the charging cycle would be 2.4 volts. Hence, at 2.4 volts, *R3* should be limiting the current to the LED enough that it won't turn on. The LED will always have a 0.7-volt drop and will want to draw a constant current. The current it needs is specified in the manufacturer's data sheet. I'll use the current draw for the 4N25 used in this circuit, which is 80 mA.

The resistor, then, needs to limit the current to less than 80 mA when the drop across it is 1.7 volts ($V_{rb} - V_{LED}$, or 2.4 volts – 0.7 volts). You can use ohm's law to calculate this as follows:

$$E = IR$$
$$R = E/I$$
$$R = 1.7 \text{ volts}/0.08 = 21.25 \text{ ohms}$$

To permit adjustments to the trip level, *R3* is a variable resistor. Use a five-turn, 100-ohm trimmer resistor to provide maximum flexibility.

It's probably best to use point-to-point wiring for construction of the circuit due to its power nature. Component placement isn't critical, except that *C1* should be located as close as possible to *U1* to ensure that it performs its job properly.

Notice again that this circuit uses separate grounds for the battery and computer circuits. The optical coupler provides the physical isolation between the two power supplies. Be sure that you keep these grounds separate when building the circuit.

The Part List for the circuit accompanies Fig. 8. Figure 9 shows an example of how you might lay out the components on perforated board that

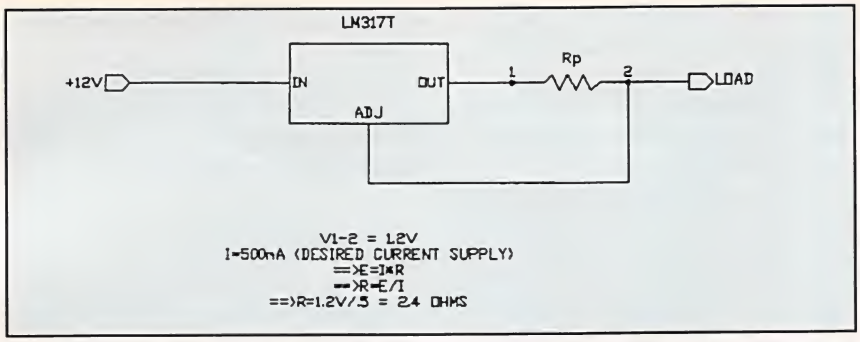


Fig. 11. Example of a simplified constant-current recharging circuit for a lead-acid battery.

has holes on 0.1" centers.

The following procedure is for testing 12-volt circuits. For a 6-volt circuit, use the numbers in parentheses. Again, you need a dual-voltage power supply to test this circuit.

(1) Connect Channel 1 to +18 volts (in test circuit) and Channel 2 to 5 volts (in test circuit).

(2) Set Channel 1 to 12 volts and Channel 2 to 5 volts.

(3) Connect a dc voltmeter or a multimeter set to the dc-volts function between circuit common (denoted by the open arrow) and TP1. Adjust *R1* until the reading at TP1 is 14.4 (7.2) volts.

(4) Connect a load resistor to the battery connection to simulate the battery as a load for testing. The load resistor value can be calculated using the formula $R_{load} = 5 \times R_b$. If R_b 12.5 ohms, R_{load} is 62.5 ohms at 10 watts.

(5) Measuring the drop between TP2 and ground, you should obtain a reading of 12 (6) volts. If not, tweak the value of the load resistor to attain the proper voltage drop.

(6) Measure the voltage drop between TP1 and TP2. This should be 2.4 volts. The circuit now simulates the end-of-recharge condition.

(7) Connect your logic probe to monitor TP3, and adjust *R3* until TP3 just goes low to set the trip point for feedback to the computer indicating that the end-of-the charge cycle has been reached.

(8) Disconnect the old load resistor. Calculate and connect the next load resistor, which will simulate a depleted battery.

(9) Check the voltage drop between TP2 and ground. It should be 8 (4.8) volts. If not, tweak the value of the load resistor to obtain this voltage drop.

(10) Measure the voltage drop between TP1 and TP2. It should be 6.4 (3.4) volts. If not, change the value of R_b and return to Step 8.

(11) Verify that TP3 is high with your logic probe.

Multi-Mode Recharger

Constant-current charging will be used for recharging the Ni-Cd batteries used in the robot, circuitry for which is detailed in Fig. 10.

In standard mode, the Ni-Cd battery is recharged at 0.1 times its normal rated discharge current. For a 5-AH battery, the normal rated discharge current is 1 ampere over 5 hours. Therefore, it would be recharged at 0.1 ampere in the Standard mode. In this mode, charging is complete in 36 to 48 hours. In the Quick mode, recharge rate is increased to 0.33 times normal rated discharge current. So, a 5-AH battery would be recharged at 0.33 ampere in Quick mode. In this mode, charging is complete in 4 to 5 hours. In the Fast mode, the recharge rate can be as great as two times its rated discharge current.

Your circuit will use 1.5 times the rated discharge current. A 5-AH battery in this case would be recharged at 1.5 amperes and would be completely recharged in 30 minutes to 2 hours.

The circuit shown in Fig. 10 supports all three recharging modes. It uses an LM317T in constant-current mode, with current-control resistors *R10*, *R11* and *R12* switched in and out by three spst reed relays.

Recall that the LM317T has an internal regulation loop that takes a feedback at its ADJ terminal and maintains V_{out} at 1.2 volts greater than the voltage at ADJ. In constant-current mode, you put a program resistor in line with V_{out} and tap the feedback to ADJ off the downstream side of the resistor. The regulator then will always attempt to maintain a 1.2-volt drop across the resistor. By properly setting the value of the resistor, you can program the supplied current.

To illustrate this, let's use the example simplified constant-current circuit shown Fig. 11. Here, R_p is the program resistor. The drop across the resistor (between points 1 and 2) will always be 1.2 volts, due to the inherent regulating nature of the LM317T. Assume that the circuit is supposed to supply 500 mA of current and that there's enough information to calculate R_b. The procedure is as follows:

E = IR
R = E/I
R = 1.2 volts/0.5 ampere
R = 2.4 ohms at 1 watt

Looking back at Fig. 10, you'll notice that the operation is the same. In this circuit, though, there are three program resistors instead of one, each controlling current for a separate mode of recharging: Standard, Quick and Fast. To calculate the values of these resistors, you must know the rated discharge current of the battery. This can be determined from the equation:

$$I_d = AH/5 \qquad \textbf{(Eq. 3)}$$

where I_d is rated discharge current and AH is ampere-hour rating.

When the rated discharge current is known, you can calculate the values for *R10*, *R11* and *R12* using the following equations:

$$R10 = 1.2 \text{ volts}/(0.1 \times Id) \qquad \textbf{(Eq. 4)}$$
$$R11 = 1.2 \text{ volts}/(0.33 \times Id) \qquad \textbf{(Eq. 5)}$$
$$R12 = 1.2 \text{ volts}/(1.5 \times Id) \qquad \textbf{(Eq. 6)}$$

All three of these resistors should be rated at a minimum of 5 watts to prevent overheating. Recharging mode is selected by inputs M1 and M2 into two-to-four-line decoder *U3*. The following shows how M1 and M2 select recharge mode:

M1	M2	Recharge Mode
0	0	Not Charging
1	0	Standard
0	1	Quick
1	1	Fast

The outputs of *U3* drive an npn transistor amplifier stage that provides

enough current to turn on the reed relays. The remainder of the circuit should look familiar. Zener diode *Z1* and resistor *R1* make up a +5.1-volt reference for the circuit. Chip *U2* and its supporting circuitry act as a voltage monitor. When the Ni-Cd battery's voltage gets to its fully-charged state, the charging cycle is complete, at which time, *U2* detects this condition and notifies the computer.

Construction method for this circuit isn't critical, though you may find point-to-point wiring the best way to go. The only testing and calibration that is required for this circuit is to ensure that the relays are working properly and to set the trip point for the end-of-charge voltage monitor.

Connect Channel 1 of the power supply to +18 volts (for the circuit under test). Turn on the amp detect switch for Channel 1 and then power. Set Channel 1 for +12 volts. Now, follow this procedure for testing and calibration:

(1) Use your voltmeter to check the potential at TP1, which should be 5 volts. If not, check to see the zener diode for heating. If so, increase the value of *R1* and replace the zener diode. If heating isn't the case but TP1 isn't at 5 volts, remove power and check your wiring.

(2) Use your logic probe to check TP2, TP3 and TP4, which should all be high. Also, if any of the relays is on or these test points are high check the logic state of TP5 and TP6, both of which should be low. If not, ensure that *R14* and *R15* are performing their function. If TP5 and TP6 are low, replace *U3*.

(3) Use a jumper wire to connect M1 to +5 volts. With your logic probe, check that TP2 is high and that RE1 is on. If not, replace *U3*. Repeat this procedure for all combinations of high and low on M1 and M2 and verify that the proper relay is energizing.

(4) Connect the output of Channel 2 to the battery connection on the circuit (TP7). Set Channel 2's output to 8.0 (4.8) volts.

(5) Ensure M1 and M2 are low. This puts the circuit in No Charge mode so that the end-of-charge trip point can be set.

(6) Connect your logic probe to TP8. Adjust *R5* until TP8 just goes low and then adjust it back to where TP8 is high. Your trip point is now set.

Summing Up

With the material presented in this article, you can easily combine the monitoring and recharge circuits together to form an intelligent power system that will allow a robot to make efficient use of its on-board power system. Conversely, you can use these circuits separately in non-robotic applications. A good example would be the application of a single-board computer (SBC) in a car. Because of its inherent properties you can use an Ni-Cd battery as your power source and apply the circuits in this article to monitor and control the recharging of the battery. In this case, the fact that the monitoring and recharge circuits are physically isolated from the computer will help in eliminating noise problems. ■

By TJ Byers

Intel Pushes The Pedal To The Metal

Intel's new microprocessor chips hit 100 MHz

If you've been following the PC story for any length of time, it's obvious that the desktop computer has come to a major crossroad. Not since Intel's step up to the 386/486 platform has such a bold move been made. Yes, I'm talking about Intel's Pentium processor. Running standard PC applications, Pentium is 87% faster than today's fastest 486 chip and nearly 175% faster than the 66-MHz 486DX2. But this is only part of the story. Pentium represents an entirely different concept in PC computing—a concept that will power the PC into the next century. A good comparison would be the move from horse and buggy to the gasoline-powered vehicle.

Much like the 486 processor series, the Pentium processor family consists of four chips, each running at a different clock speed. Although Pentium is based on new technology, it's fully software-compatible with previous Intel processors, including 286s, 386s and 486s. It's obvious that Intel has been forward-thinking enough in this regard to preserve the value of your current software.

Every Pentium processor incorporates superscalar architecture, 64-bit external data bus, separate instruction and data caches and two math coprocessors. The newest members of the Pentium family—the Pentium-90 and Pentium-100—also include SL technology for power management, an on-chip multiprocessor interrupt controller and dual-processor mode.

Pentium Anatomy

At the heart of the Pentium processor is mainframe-inspired superscalar architecture, which is built around two instruction pipelines. Each pipeline, named *u*-pipe and *v*-pipe, performs independently of the other. This lets Pentium execute two integer instructions in a single clock cycle.

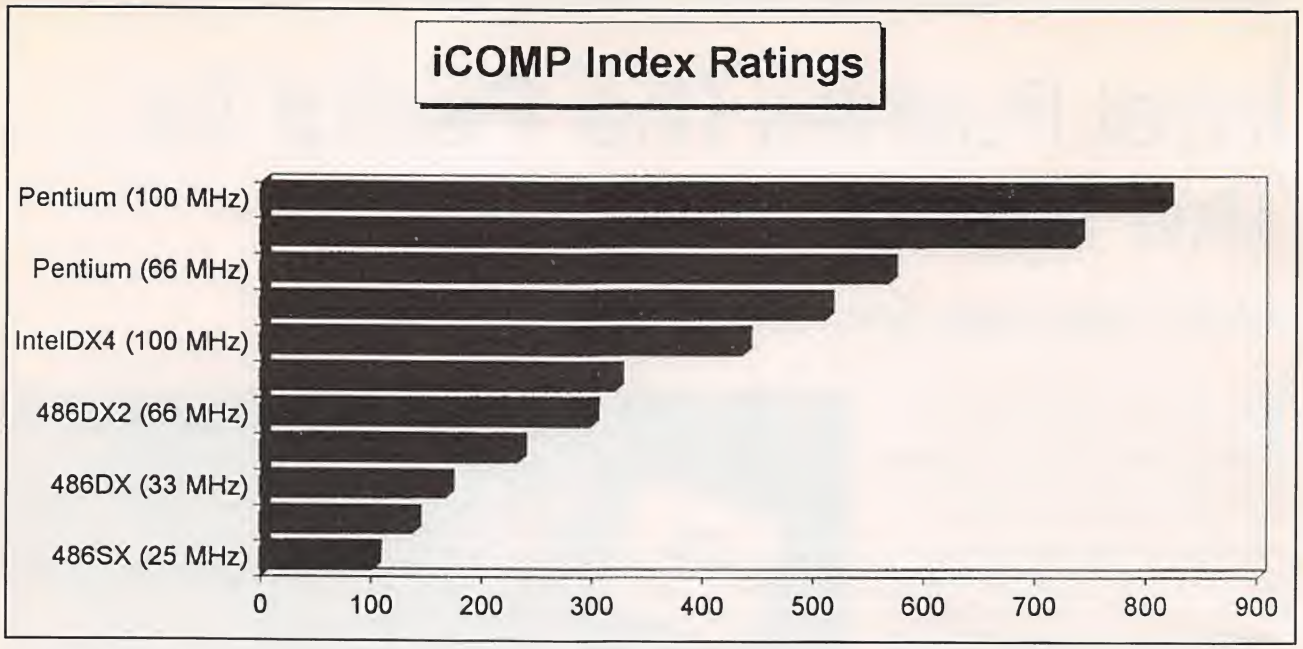
Pentium's pipelines are similar to the single pipeline of the 486 processor. Like the 486 pipeline, Pentium's pipelines execute integer instructions in five stages: Prefetch, Instruction Decode, Address Generate, Execute and Write-Back. An instruction is put into the pipeline at stage one, Prefetch. There it travels through the pipeline, like oil flows through the Alaskan pipeline, until it finally comes out the other end. However, when an instruction passes from Prefetch to Instruction Decode, the pipeline is then free to accept another instruction. This permits the pipeline to execute five operations simultaneously, instead of having to wait for the first operation to complete before it begins a new one.

With the proper software, Pentium can issue two instructions at once—one to each pipeline—in a process known as *instruction pairing*. However, the instructions must be simple microcodes, and the *u*-pipe must receive the first instruction, followed by the *v*-pipe's instruction. Each pipeline has its own math coprocessor, address-generation circuitry and interface to the data cache.

Unlike the 486, which has a single 8K cache, Pentium features two 8K caches, one for instructions and the other for data. A cache serves as a temporary storage cupboard situated between the CPU and system RAM. The cache stores the most-recently-used instructions and data. Since instructions and data are often repeated over and over, chances are good that the information the CPU seeks is in one of the two caches. Therefore, when the CPU needs an instruction or data, it queries the on-chip caches first, which speeds operations by more than ten-fold.

Running standard PC applications, Pentium is 87% faster than today's fastest 486 chip and nearly 175% faster than the 66-MHz 486DX/2.

Another improvement is that Pentium's caches are two-way associative,



The 100-MHz IntelDX4 processor delivers a new performance point between the 486DX2-66 and Pentium processors. Only alternate bars on the graph are identified. From top to bottom, the missing ID labels are: Pentium (90 MHz), Pentium (60 MHz), IntelDX4 (75 MHz), DX2 (50 MHz), 486SX (33 MHz).

rather than the simpler direct-mapped method used by competitive CPU vendors. The difference is that Pentium's two-way associative cache searches only two 32-bit lines before it gives up and goes to system RAM. Direct-mapped caches search the entire cache before they access system RAM, a move obviously takes longer.

Pentium's two-way set-associative caches also have an edge on the 486's two-way associative cache. Instead of using 16-byte lines like the 486, Pentium has 32-byte lines, which better match Pentium's 64-bit bus and improve the probability of getting a cache "hit."

Use of separate caches for instructions and data works in conjunction with other elements of Pentium's design to provide increased performance and faster throughput. For example, the first stage of the pipeline is Prefetch, during which time information is fed into the pipeline. In a single-cache architecture, like that used for the 486 processor, the CPU must decide whether the information is an instruction or data. Providing separate caches for instructions and data eliminates the decision-making process and allows both operations to take place simultaneously under the dual-pipeline architecture.

Pentium further increases performance by using a small on-chip cache called the Branch Target Buffer, or BTB, that provides dynamic branch prediction. Simply put, when an instruction leads to a branch decision, the BTB remembers the instruction and address of the branch taken. When the same or similar instruction/address pattern appears, the BTB predicts the best path to take—with a good hit rate.

The data cache has two interfaces, one to each of the pipelines. This allows it to supply data for two separate operations in a single clock cycle. It also has write-back to main system RAM.

When data in Pentium's data cache is changed—and only then—it's written into the system's main memory. This is called write-back caching. The other method commonly used is called write-through caching in which the data is written to main memory each time the cache is accessed, whether or not the data has changed. Obviously, write-back caching saves time. The trade-off is data security. If power fails before a write-back occurs, data in the cache is lost (though Pentium can be dynamically configured to support write-through caching).

Pentium employs a number of techniques to maintain the Integrity of the data when the chip is working. Error detection is done at two levels: on-chip cache memory validity and parity checking via Pentium's external data bus and address lines.

Pentium includes a of number built-in features for testing the integrity of the chip, including a Built-In Self Test, BIST (Intel's acronym for the POST—Power-On Self Test—procedure with which you're probably already familiar), that tests 70% of Pentium's components upon resetting the chip. There's also a Probe Mode that provides access to Pentium's software registers for the purpose of determining the current state of the processor.

Use of separate caches for instructions and data works in conjunction with other elements of Pentium's design to provide increased performance and faster throughput.

To ensure that the data in the cache and in main memory are consistent with each other, the data cache implements a cache-consistency protocol called MESI, which defines four states: Modified, Exclusive, Shared and Invalid. The four states are assigned to each line of the cache based on actions performed on that line by the processor. By obeying the rules of

Breaking The Speed Barrier

Most processors that use bipolar technology, like the 486DX, have a speed limit of 50 MHz. To break this speed barrier, the Pentium uses BiCMOS technology. To understand why the new technology is needed, you have to know something about semiconductor operation. Specifically, you need to know the two operating states of a transistor: saturated mode and active mode.

When a transistor is in saturated mode, very little voltage is dropped across it and it dissipates almost no power—or heat. When a transistor is in active mode, there's a voltage drop across it and, consequently, it behaves like a resistor that dissipates power—and heat—according to Ohm's law. For example, at the 50% point, where most stereo amplifiers operate, half the power is dissipated by the transistor. Digital circuits typically operate in saturated mode, and stereo amplifiers operate in active mode.

Now keep in mind that there's no such thing as a perfect switch. It takes time for the signal to go from logical 0 to logical 1 and back again. This is called the transition time, and it's broken down into risetime and falltime. During a transition, the transistors on the chip go into active mode and generate heat. The longer a transistor stays in active mode, the more heat it produces. At slow switching speeds, the transistor has time to dissipate the heat before the next transition occurs. But as speed increases, so does the number of times per second the transistor is active, leaving less time for the semiconductor to cool down. Consequently, temperature rises. Finally, a point is reached at which heat build-up is greater than the heat dissipated by the transistor, which will eventually lead to a Chernobyl-like meltdown. For bipolar transistors, this limit is 50 MHz.

Pentium processors, on the other hand, use BiCMOS (bipolar complementary metal-oxide semiconductor) technology, a marriage of bipolar and CMOS technologies. CMOS is noted for its low power demands, even when the transistor is in active mode. Unfortunately, by itself, CMOS tops out at just about 20 MHz because transition time isn't nearly as fast as with bipolar, and you can't go any faster than the risetime and falltime permit.

Enter the bipolar driver. By using a bipolar transistor to force the CMOS transistors through the switching transition, you get the best of both worlds—low power dissipation and fast clock speeds.

BiCMOS by itself still isn't enough. Remember that the amount of time the transistor spends in active mode, the more power it dissipates. And the more voltage difference there is between logical 0 and logical 1, the longer it takes to go from one plateau to the other. For example, it takes about 20 times longer for a signal to go from 0 to 100 volts than it does to go from 0 to 5 volts. Pentium-60 and Pentium-66 processors use conventional 5-volt technology, while faster Pentium-90 and Pentium-100 processors use low-power 3.3-volt technology.

Another way to increase speed is to decrease the distance between semiconductor components. Theoretically, electricity should flow at the speed of light (186,300 miles per second), which is true if the connecting wires were a vacuum. In reality, electricity flows by knocking one electron into another, which hits another, and so on down the line until an electron comes out the other end of the wire. After all is said and done, the speed is actually about one-billionth the speed of light. Therefore, the shorter the connecting wire between two points, the fewer electron collisions involved and the faster the current flows.

Pentium-60 and Pentium-66 use 0.8-micron (a micron is one-millionth of a meter) spacing and Pentium-90 and Pentium-100 use 0.6-micron spacing. Another way to decrease the space between components and increase speed is to provide multiple levels of metal for interconnection. Intel's current 0.6-micron BiCMOS technology utilizes four metal layers. Experimental Pentiums run as fast as 150 MHz.

While BiCMOS and sub-micron technology have been around for a while, the Pentium chip is probably the first time you're likely to have seen it at work. Expect to see a lot more as the PC continues to push the speed barrier to ever-faster limits in the near future.

the protocol during memory read/write, Pentium maintains cache continuity with system memory and avoids problems that can occur should the two go out of sync.

For situations in which data integrity is especially crucial, Pentium provides Functional Redundancy Checking (FRC). To use FRC, however, you need two Pentium chips, one acting as the master and the other as a slave. The two chips run in tandem, with the slave Pentium (called the checker) comparing its output with that of the master Pentium to avoid errors. This isn't unlike master and slave hard disks that are commonly used for network backup.

The two new on-chip math coprocessors, called Floating Point Units (FPUs), are completely redesigned. Unlike the 486, Pentium incorporates an eight-stage pipeline that can execute one floating-point operation every clock cycle (or two operations per cycle, with the proper software).

The first four stages of the FPU pipeline are the same as that of the *u*-pipe and *v*-pipe pipelines. The final four stages consist of a two-stage Floating Point Execute, Rounding and Writing and Error Reporting. Several instructions—such as ADD, MUL and LOAD—have been hard-wired into the FPU. This lets them execute three times faster than if these instructions had to be decoded.

Pentium-90 and Pentium-100 incorporate Intel's SL technology for low-level power management...[which] enables Pentium to meet the U.S. Environmental Protection Agency's (EPA) Energy Star guidelines.

Pentium-90 and Pentium-100 incorporate Intel's SL technology for low-level power management. This enables Pentium to meet the U.S. Environmental Protection Agency's (EPA) Energy Star guidelines. SL technology operates at the microprocessor and system levels.

Power management at the processor level involves putting the processor into a low-power state during non-processor-intensive tasks, such as word processing, or into a very-low-power state when the computer isn't in use ("sleep" mode). Stop Clock and Auto Halt are the hardware and software mechanisms that enable the processor to operate at 0 MHz while maintaining its state and memory.

Stop Clock is a microprocessor input that permits the external clock frequency to be changed, either to operate at a different frequency or at 0 MHz (where the processor consumes 0.5 to 1 mA of power). When Auto Halt is enabled, Pentium automatically enters low-power sleep mode, as

World's Fastest 486

By now, you've probably heard or read about Intel's 100-MHz IntelDX4 processor. This processor throws down the gauntlet and sets itself up as a real challenger to the Pentium for speed and performance. So, just when you thought it was safe to brave the storm and invest in a high-end PC, the IntelDX4 comes along to cloud the issue. Hands down, it's the world's fastest 486 processor around. Designed to fill the performance gap between the 66-MHz 486DX2 and Pentium processors, the new IntelDX4 chip can run at clock speeds up to 100 MHz. This is up to a 50% improvement over the current 66-MHz 486DX2 microprocessor. Moreover, it gives Pentium-60 a run for its money.

Unlike the Pentium processor, the IntelDX4 isn't a radical departure from its 486 predecessors. The IntelDX4 is offered in both a 168-pin PGA (bed-of-nails) package and a thermally-enhanced 208-pin SQFP (square flat pack), just like "traditional" 486 processors. It's also pin-compatible with existing 486 processors, which allows PC manufacturers to quickly modify existing 486 motherboards for IntelDX4 performance. In fact, the only design change required is the addition of a 3.3-volt regulator for the DX4's power source.

Under The Hood

Like past 486 processors, the IntelDX4 is available in a variety of clock speeds—75, 83 and 100 MHz—and operates at a faster internal speed than it does externally. Depending on your choice, the IntelDX4 can operate as a clock doubler, a clock tripler or a clock two-and-a-halfer (see Table 1). Vendors like this because it lets the IntelDX4 work with standard motherboard bus speeds of 25, 33 and 50 MHz. In the cases of the 83- and 100-MHz chips, bus speed is vendor-selectable between 33 and 50 MHz operating frequencies.

The IntelDX4 processor incorporates the same RISC-technology CPU as the 486 does, which permits several instructions (such as MOV and ALU operations) to execute in a single clock cycle because they've been hard-wired into the CPU's firmware. When you're running at 100 MHz, this makes a big difference in throughput. There's also in internal math coprocessor (FPU) that's the same as the one used in all 486DX and 486DX2 processors.

The big difference with the IntelDX4 processor is that the on-chip cache has been expanded to 16K, which is twice the amopunt supplied in the 486 processor. While it's not divided into instruction and data as in the case of the the Pentium, it can deliver near-zero wait-state performance when high-speed second-level caching is used. The built-in memory manager unit (MMU) supports several types of bus cycles, including burst mode, which maintains an external one-clock instruction rate throughput even with inexpensive DRAMs.

Cool Technology

The IntelDX4 processor is built using Intel's new 3.3-volt technology and contains 1.6-million transistors. The power-saving 3.3-volt architecture runs cooler than traditional 5-volt logic. At 100 MHz, the IntelDX4 consumes a mere 4 watts of power. To make the IntelDX4 compatible with existing 5-volt system logic and memory components, however, it uses 5-volt-tolerant input buffers.

For 3.3-volt notebooks, the IntelDX4 operates in its native 3.3-volt environment, which provides notebook users with both desktop performance and long battery life. Typically, the 75-MHz IntelDX4—which is the chip Intel has targeted for the notebook market—consumes less than 3 watts of power for most applications. Since the 75-MHz IntelDX4 provides a dramatic performance boost and longer battery life over the 50-MHz 486DX2 typically used in high-end notebooks, you can expect to see a flood of 75-MHz IntelDX4 notebooks this summer—and perhaps a few 100-MHz IntelDX4s.

The IntelDX4 processor also features Intel's SL-enhanced power-management technology, which extends battery life in mobile PCs and enables the IntelDX4 processor to meet the U.S. Environmental Protection Agency's (EPA) Energy Star guidelines.

Pentium OverDrive-Compatible

IntelDX4-based desktop PCs give users investment protection today by offering upgradability to higher-lever performance in the future via a Pentium OverDrive processor. The Pentium OverDrive processor will be based on state-of-the-art Pentium technology at the time, and it will be designed to provide an additional 50% performance boost.

So if you want the world's fastest 486 PC and can't afford to buy a whole new system every time the ante for the 486 is upped, the upgradable IntelDX4 looks like a sweet deal.

Table 1. Intel Processor Comparison Chart

Processor	Clock Speed	Bus Speed	Price
486DX2-50	50 MHz	25 MHz	$260
486DX2-66	66 MHz	33 MHz	$360
IntelDX4	75 MHz	25 MHz	$475
IntelDX4	83 MHz	33/50 MHz	*
IntelDX4	100 MHz	33/50 MHz	$580
Pentium-60	60 MHz	60 MHz	$675
Pentium-66	66 MHz	66 MHz	$750
Pentium-90	90 MHz	60 MHz	$849
Pentium-100	100 MHz	66 MHz	$995

* To be announced.

would occur if the processor was waiting for an I/O input or keyboard response.

Intel's System Management Mode (SMM) controls power at the system level. This mode provides intelligent system management that permits the processor to slow down, suspend or completely shut down various system components, such as the modem and I/O ports.

Multiprocessing

Pentium processors can be linked together in a multiprocessor environment. All members of the Pentium family include write-back caches and the MESI protocol to support multiprocessor systems. Write-back caches reduce processor writes, resulting in reduced bus contention between multiple processors, and the MESI protocol is used to maintain cache consistency among several processors. Pentium-90 and Pentium-100 also include an on-chip multiprocessor interrupt

CPU Alternatives

While Intel has the lion's share of the CPU market, the company is getting some stiff competition. New entries from IBM, AMD, Cyrix, Digital Equipment and MIPS Technologies are giving Intel a run for its money. While these choices may seem to confuse your buying decisions, they're beneficial because they're bringing down the prices of PCs. Thanks to Apple, in tandem with Motorola, for example, a multimedia 486 system with CD-ROM drive is currently selling for $2,000 less than it did just a year ago.

- Cyrix's new 66-MHz chip, the CX486-DX2-66, is slated for a head-to-head battle with Intel's 486DX2/66, and there's a clock-doubled 80-MHz chip in the works.
- AMD was the first company to ship 3.3 volt technology. AMD's 3.3-volt, clock-tripled 486DX2-100 should hit the bricks sometime in the last quarter of 1994.
- IBM has the Blue Lightning-2, which is priced to be about $150 less than Intel's 486 equivalent.
- MIP's processors, which are made by a foundry, are used in *NT* systems from NEC and Acer. Currently, MIPS R4200 processors are EPA-compliant and run at 80 and 100 MHz.
- Digital's 166-MHz 21066-166 chip is already shipping for the PC, which is the big brother of the 100-MHz DEC chip that can be found in DEC's SPARC-compatible workstations.
- DEC's 225-MHz Alpha 21064A-225 processor should be shipping by the time you read this, which will soon be supplanted by the 275-MHz 21064A-275.

The real competition comes from Motorola. In a consortium with IBM and Apple, Motorola forged the PowerPC chip. The first PowerPC, the 601, will have a 40% boost over the Pentium processor but you have to run native applications to get this level of performance. This puts you back to square one. Sure, it's Intel-compatible, but at a speed loss! To gain the advertised performance, you need to buy new applications.

controller, called the Advanced Programmable Interrupt Controller (APIC).

The APIC supports symmetric multiprocessing, which means all processors look equal to the operating system, which includes *Windows NT*, OS/2 and Unix. Basically, each Pentium-90 and Pentium-100 contains an APIC that's one part of a very local—like on the motherboard—local-area network (LAN). A single I/O APIC controller chip from Intel or a licensed vendor can handle up to 60 processors on one motherboard.

Pentium-90 and Pentium-100 also include the dual-processor mode that enables two processors to share a single external cache. Dual-processor mode permits development of low-cost multiprocessor systems for workstations and low-end servers.

What's the catch in all this? The answer is new software. If you continue to use your old PC software, you'll get no better than a supercharged 486. Before Pentium can perform all the amazing feats described above, such as using the dual pipelines and running 60 processors in parallel, it needs special software.

No doubt, the first generation of Pentium applications will be existing software that's been recompiled. This will probably let the application take advantage of the dual-pipeline architecture, but there's no guarantee of this. For multiprocessor performance, software will have to be written from the ground up.

The big story here is that the desktop PC has officially stepped into the parallel-processing world—an area heretofore claimed by miniframe and mainframe systems. What does this mean to the average PC user? For the moment, very little. For typical word-processing, desktop-publishing and spreadsheet use, you'll never notice the benefit. However, if you want to work in virtual reality and do all the good things promised for the next century, a single Pentium is just a beginning. ■

By Joe Peschel

Exploring Hard-Disk Compression

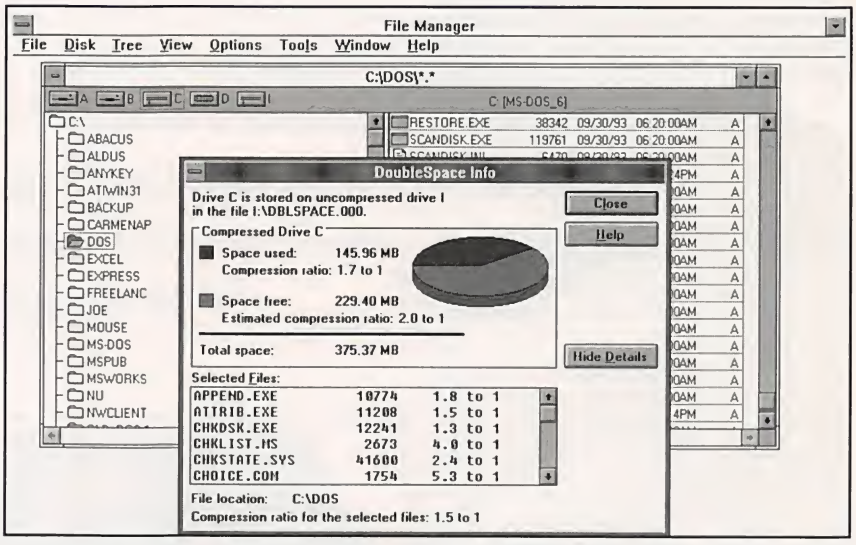
What's happening in the marketplace, installation and implementation, batch testing and handy utilities

When Microsoft introduced its DoubleSpace compression product as a utility integrated into MS-DOS 6.0 and later MS-DOS 6.2, the company popularized disk compression for the non-technical masses to the extent that some users may have believed the concept of squeezing data a new one. Prior to the arrival of DoubleSpace, however, Stac Electronics offered a very popular *Stacker* product and IIT's *Xtradrive* and AddStor's *SuperStor*, once incorporated into DR DOS, courted a strong core of compression fans. At the time, Vertisoft, too, probably felt lucky to license its *DoubleDisk* product to Microsoft.

There was good reason for the popularity of disk compression for the masses. After all, what better way was there to save money and expand your storage space than buying a program that will increase the capacity of your drive, no matter how large, for the same amount of money? In fact, on-the-fly loss-less compression has become so popular that Novell and IBM joined Microsoft in parading the integration of disk compression into their operating systems. A great situation for consumers you might think, but not so fast.

In late February, Microsoft was found guilty of infringing on patents held by Stac. Stac, was, in turn, found guilty of misappropriating Microsoft's pre-loading scheme. The upshot was that Microsoft removed DoubleSpace from its MS-DOS and began shipping an MS-DOS 6.21 version that includes *no* compression routine.

The picture gets worse. AddStor went out of business, and Vertisoft is no longer shipping compression products. IBM offered a fully licensed *SuperStor/DS* product with PC DOS 6.1. At press time, it appeared that *SuperStor/DS* will be includedin PC DOS 6.3. IBM also has an agreement with Stac Electronics whereby it may include a version of *Stacker* in subsequent products.



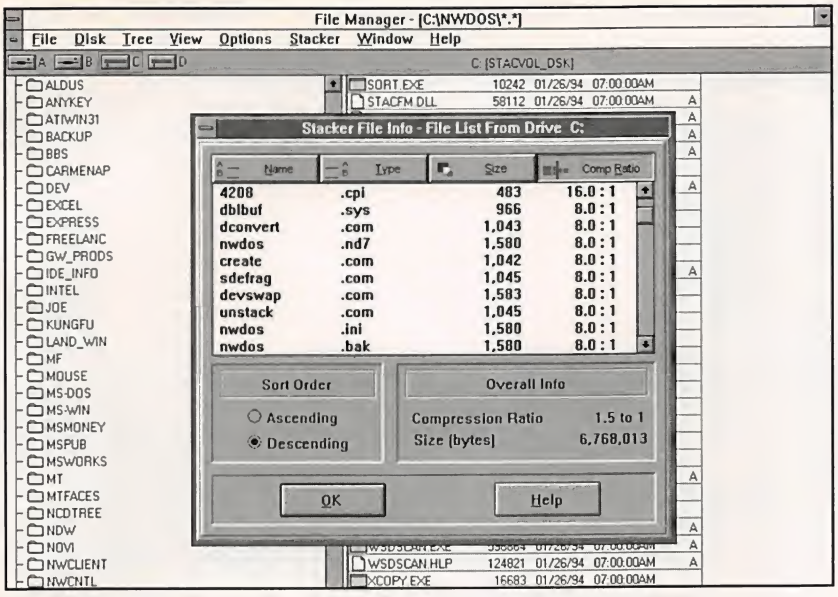
Files selected from the *Windows* File Manager, showing DoubleSpace 6.2 compression ratios.

There's hope for consumers, though. IIT settled a dispute with Stac a couple of years ago that should shield it against future litigation. Novell incorporates *Stacker* Version 3.12 in its DOS. And Microsoft will continue to support DoubleSpace while it scrambles to develop or license another compression product. At this writing, it was uncertain what this product might be. But since other OS developers offer compression, it seems safe to state there will be one. I'm betting Microsoft may try to license an iteration of a *Stac* program. Meanwhile, litigation hopefully aside, Stac's new 4.0 version touts breaking the 2:1 default compression ratio, transforming a 200M disk into a 500M unit.

How Compression Works

Simply put, data compression is the process of encoding a body of data, text or graphics, for example, into a body that requires less space. Programs like *PKZIP*, self- extracting files and installation programs that "unsqueeze" or "uncrunch" data are examples of compression and decompression routines that make installation, communications and storage more efficient. Though the idea is similar to disk compression, the process in neither on-the-fly nor transparent.

Today's disk-compression programs, like the above examples, com-



Stacker 3.12 reports compression ratios under Novell DOS.

press information by reducing the redundancy in the data—and they do it on-the-fly, with no visibility to the user and without any loss of the original data. (There are lossy compression schemes, too, that are useful for retrieving image data, for example, where exact retrieval isn't crucial. To paraphrase a compression guru at Stac, say a picture has a blue sky background, but many of the shades of blue are indiscernible to the naked eye. When the compressed data is decompressed, the lossy decompressor may ignore several infinitesimal shades. The result is that no crucial data is lost as far as the human eye is concerned, but the process is lossy. In this article, though, we'll be looking only at loss-less techniques.)

The idea of compression, so popular now, can be traced back to the 1940s and 1950s when algorithms for reduction of data redundancy were developed by D.A. Hummel and others. The actual implementation wasn't viable, however, until components sufficiently inexpensive and powerful were developed to make the trade-off between performance and increased storage space optimal. In the late 1970s, the LZ-1 and LZ-2 (also known as LZ-77 and -78) algorithms of Lempel and Ziv provided a loss-less compression method on which the programs here are based (which explains, in part, all the litigation). Today's 386 and 486 systems relegate the real-world computing trade-off to next to nothing.

The Lempel-Ziv algorithm employs the sliding-dictionary and sliding-window method of pointing to data, rather than a static dictionary. At the outset, a dictionary is built that keeps track of all the character strings. A sliding window, in Stacker's case about 2,048 bytes, passes over a source string of data with two parameters: displacement and length. The information seen through the window updates the dictionary so that you might think of strings of data as entering and leaving. What occurs is basically this: when a repeated string is found, a token marks it and its reference point. While some compressor windows look for strings as small as three bytes, Stacker looks for two-byte strings.

Take a small text file such as the following:

"It was the best of times, it was the worst of times."

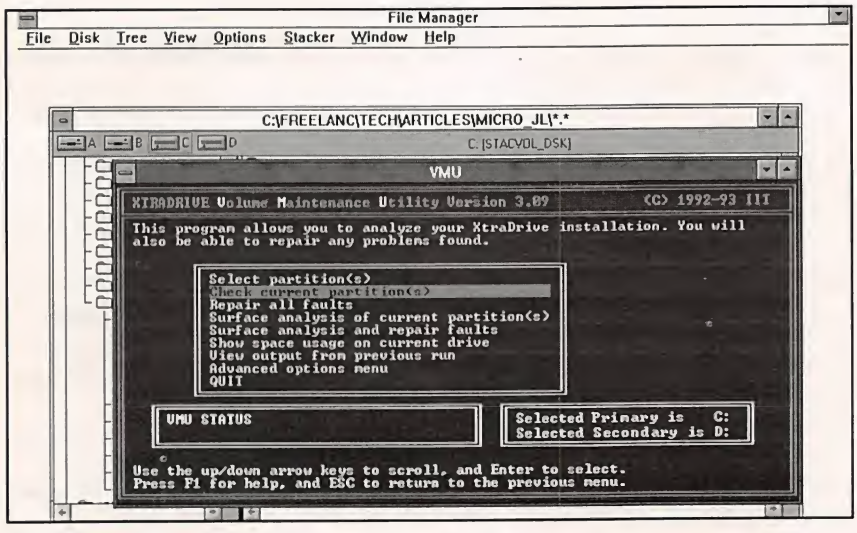
(*A Tale of Two Cities*, Charles Dickens)

The character strings are searched by the sliding window while pointers and tokens keep track of repeated data. A quick look reveals a few of the repeated words: it, the times. But the sliding window finds more repeated strings: Stacker, for example, notes the recurrence of the ST space and the IT string, to mention a few repeated strings, and compresses the recurring data while keeping track of where it first found it. Consequently, the file, which normally occupies 54 bytes is highly compressible, under *Stacker* 4.0, 21.3:1.

Not all data can be compressed, however. .ZIP and .ARC files generally can't be compressed further, nor files that are self-extracting, which sometimes have .LZ* extensions. Graphic files—such as .PCX, .TIF and .ICO files—.TXT and .BAT files, and word-processing documents are files that are highly compressible.

Not so much repeated data exists in .COM, .EXE, .DLL and .WAV files, but they'll compress at ratios ranging from around 1.5:1 to 2.5:1. (See the accompanying tables.)

To discover how files are stored on

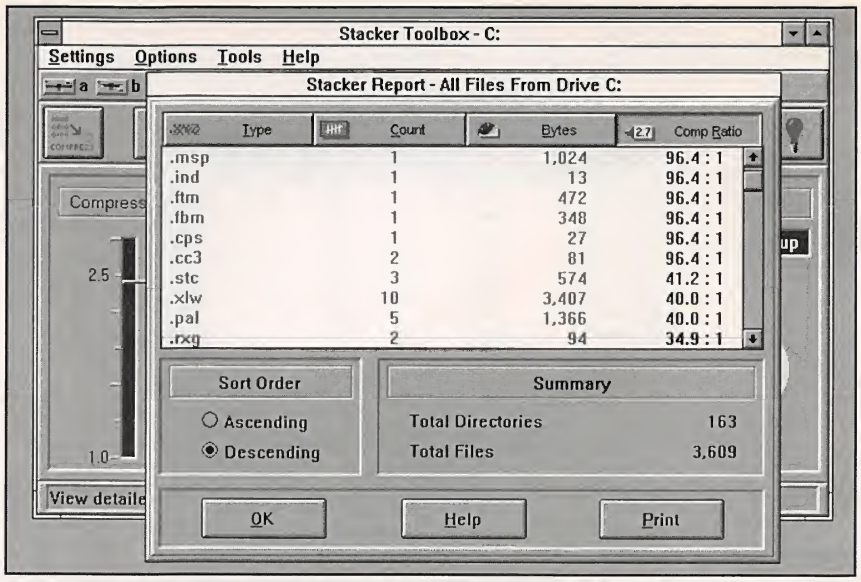


The *Xtradrive* 3.0 Volume Maintenance Utility running half-screen as a DOS application under *Windows* File Manager.

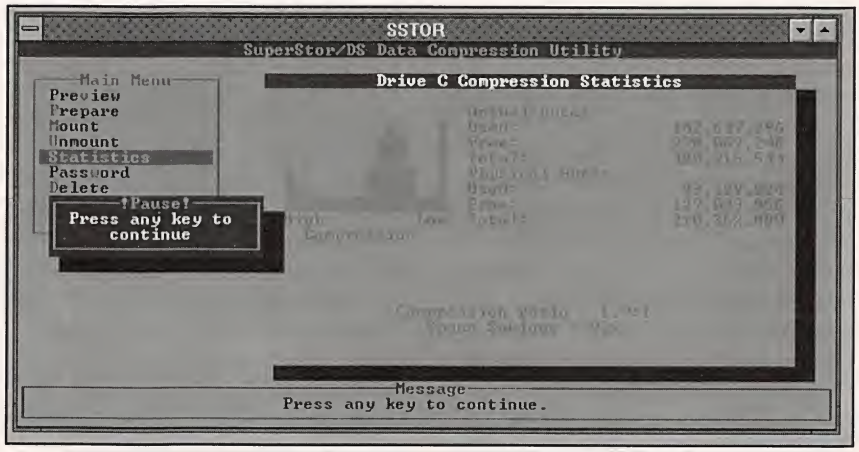
compressed drives, let's look at the way files are stored on our uncompressed 202M drive. Data is normally saved to 512-byte sectors, which are the smallest units of a cluster on this or almost any DOS drive. Our drive has eight sectors per cluster, giving a cluster size of 4K, or 4,096 bytes. Space for data is allocated by the cluster, also called an allocation unit, of which there are 51,706. Since even the most-minute file consisting of one byte needs an entire cluster, plenty of storage space in the cluster it occupies is wasted, to the tune of 4,095 bytes, when saving a one byte file. On average, Stac asserts, half a cluster is wasted throughout the drive.

Compressors go a long way in using the wasted space on our drive with its 128M of data and an average file size of about 34K (34,816 bytes). Instead of saving only one file to a home at a particular cluster, compressors save files to individual sectors. To make the numbers easier to interpret but still point out wasted space, look at an uncompressed file that occupies 1,300 bytes. Three sectors are normally needed to store the file; 2,796 bytes of the cluster are wasted. Most compressors will shrink our file, for example, by 50%, or at 2:1, to 650 bytes, so that it takes up only two sectors. This leaves 3,072 apparent bytes of the cluster unused. But since the drive is compressed (at 2:1, we'll suppose) before we copy our file, the usable space in the cluster amounts to 6,084 bytes.

Most compression products that achieve nearly a 2:1 default compression ratio behave in this manner, except for *Stacker* 4.0, which goes a bit further to achieve its estimated default ratio of 2.5:1. *Stacker* 4.0 employs what it calls SmartPack to save data from up to three different clusters in the free space of a single sector. (While individual file-compression ratios here range as high as 96:1, based on mathematical formulas, please don't expect such ratios across the entire drive.)



Stacker 4.0 reporting compression ratios through the *Stacker* Toolbox. Notice that some files compress as high as 96:1, due to the size of the cluster and *Stacker*'s Smart Pack technology.



PC DOS *SuperStor/DS* report, under DOS, of used bytes, with some graphic info.

Installation & Implementation

Stac Electronics' *Stacker* 4.0 and IIT's *Xtradrive* are stand-alone programs that have their own installation routines and can be installed on MS-DOS, PC DOS and Novell DOS systems. But since compression programs are built into PC DOS, MS-DOS and Novell DOS, it's necessary to install the integrated compressor using the native operating system.

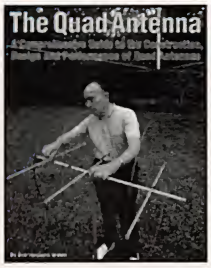
You can install, for example, *Xtradrive* or *Stacker* 4.0 on a PC DOS system, but you can't expect to install Novell's version of *Stacker* 3.12 on a PC DOS system. (Certainly, don't try to install compressors simultaneously.) As Microsoft's DoubleSpace drive is created by running dblspace, IBM's compressed *SuperStor/DS* drive is created by executing Sstor. Novell DOS setup, when re-run, can create the *Stacker* 3.12 drive. Naturally, all of these programs provide a suite of utilities, which we'll look at later, for repairing and maintaining compressed drives.

Most of the compression programs, including those incorporated in the OS, load before CONFIG.SYS and are processed with the hidden system files *a la* DoubleSpace. (See the loading diagram.) Matter of fact, *SuperStor/DS* loads DBLSPACE.BIN and Stacker replaces DBLSPACE.BIN with a STACKER.BIN file.

A driver must be present for all of these programs to load into upper memory. *Xtradrive* relies on the presence of a device driver to execute compression even in base memory, but its hidden file, IITV3.VOL replaces

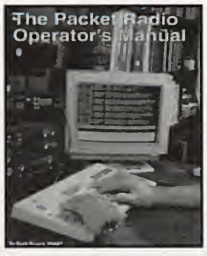
CQ Books and Videos

The Quad Antenna



Hams love antenna books and this book is no exception. Written by world renowned author Bob Haviland, W4MB, The Quad Antenna is the authoritative technical book on the design, construction, characteristics and applications of Quad Antennas. Discover how to easily build a quad antenna for your station that will help you fill your logbook with rare DX that you have only dreamed about before. **Order No. QUAD..... $15.95**

The Packet Radio Operator's Manual



This book is written by CQ columnist and Amateur Radio Packet authority Buck Rogers, K4ABT. An all new introduction and guide to packet operation, it is the perfect single source, whether you're an advanced user or just starting out. Learn about packet radio without all the technical jargon. Also included are detailed hookups for dozens of radio/packet controller/computer combinations, making this book the definitive resource for the active packet user. **Order No. PROM..... $15.95**

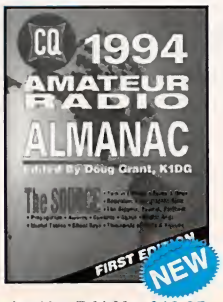
Ham Radio Horizons: The Book

Written by Peter O'Dell, WB2D, this is a book about ham radio that every beginner can enjoy! If you want to get in on the fun and excitement of Amateur Radio, Ham Radio Horizons is the perfect way to get started. HRH is full of tips from expert hams in: DXing, Contesting, Serving the Public, Ham Radio in Space, Experimenting, Digital Communications — you name it! This exciting book is an excellent gift to a prospective ham or for use in your club's licensing classes and library.
Order No. BHOR..... $12.95

The Vertical Antenna Handbook

Take advantage of the 20 years of research and practical experience of naval communications engineer Capt. Paul H. Lee, USN(ret), N6PL. Learn the basic theory, design, and practice of the vertical antenna. Discover easy construction projects such as a four-band DX vertical or a broadband array for 80 meters. Ever wonder how to build a functional directive vertical system? Paul Lee can get you started today!
Order No. VAH..... $9.95

1994 Amateur Radio Almanac

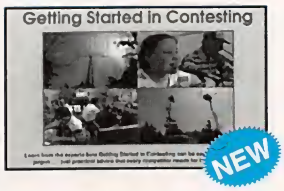


If you're like most hams, you'll be fascinated by the thousands of facts, tables, graphs, maps, and other information to be uncovered in the **CQ 1994 Amateur Radio Almanac.** CQ's Almanac puts it all right at your fingertips, providing a resource that you'll refer to over and over again. This is one book you can't be without!
Order No. BALM....$19.95

Get Started with CQ's New Video Library!

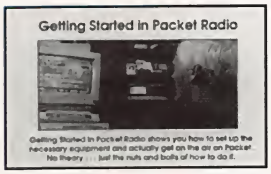
Also Available In PAL format

Getting Started in Contesting



Whether you're a newcomer to contesting or an experienced veteran, CQ's **Getting Started in Contesting** is for you! You'll get advice and operating tips from some of contesting's most successful competitors, including Ken Wolff, K1EA, Dick Newell, AK1A, and CQ's own contest columnist, John Dorr, K1AR. Order our contest video and watch your scores begin to climb! **Order No. VCON....$19.95**

Getting Started in Packet Radio

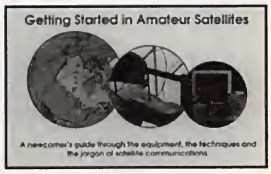


This video will help de-mystify the exciting but sometimes confusing world of packet radio. Learn how to get started using your computer on the radio. Included are step-by-step instructions on making packet contacts and using packet bulletin boards, networks and satellites. **Order No. VPAC.. $19.95**

Getting Started in Ham Radio

This is a fast-paced video introduction to the fascinating world of ham radio. CQ's experts show how to select equipment and antennas; which bands to use; how to use repeater stations for improved VHF coverage; the importance of grounding and the basics of soldering. How to get the most out of your station, whether it's home-based, mobile or handheld. **Order No. VHR $19.95**

Getting Started in Amateur Satellites



Learn with this video how veteran operators set up their satellite stations. Find out how to locate and track ham satellites with ease. Watch operators access current satellites and contact far ranging countries around the world. This video is filled with easy to understand advice and tips that can't be found anywhere else. **Order No. VSAT..... $19.95**

Getting Started in DXing

Top DXers share their experience with equipment, antennas, operating skills, and QSLing. You'll see hams work rare DX around the world. If you're new to DXing, this video is for you! All this valuable information may well give you the competitive edge you need to master the exciting world of DXing.
Order No. VDX..... $19.95

Ham Radio Horizons: The Video

This introduction to Amateur Radio is an excellent complement to the Ham Radio Horizons book. Enjoy seeing all aspects of ham radio ranging from what it takes (and costs) to get started to how you can get your ham license. Designed for the general public, HRH is ideal for public events, presentations to community groups and as an opening to your club's licensing courses! There's no better way to introduce someone to ham radio. **Order No. VHOR.....$19.95**

For Fastest Service,
Order Toll Free 1-800-853-9797
Or FAX 516-681-2926 Also available at your local dealer!

YES! I want to learn from the experts. Rush me my book(s)/video(s) right away!

Qty	Item #	Description	Price	Total Price
			Shipping/Handling	
			Total	

Please add $4 shipping & handling. FREE shipping & handling for orders $50 and over.
Please make your check or money order payable to: CQ Communications, Inc.

Name _____ Callsign _____

Address _____

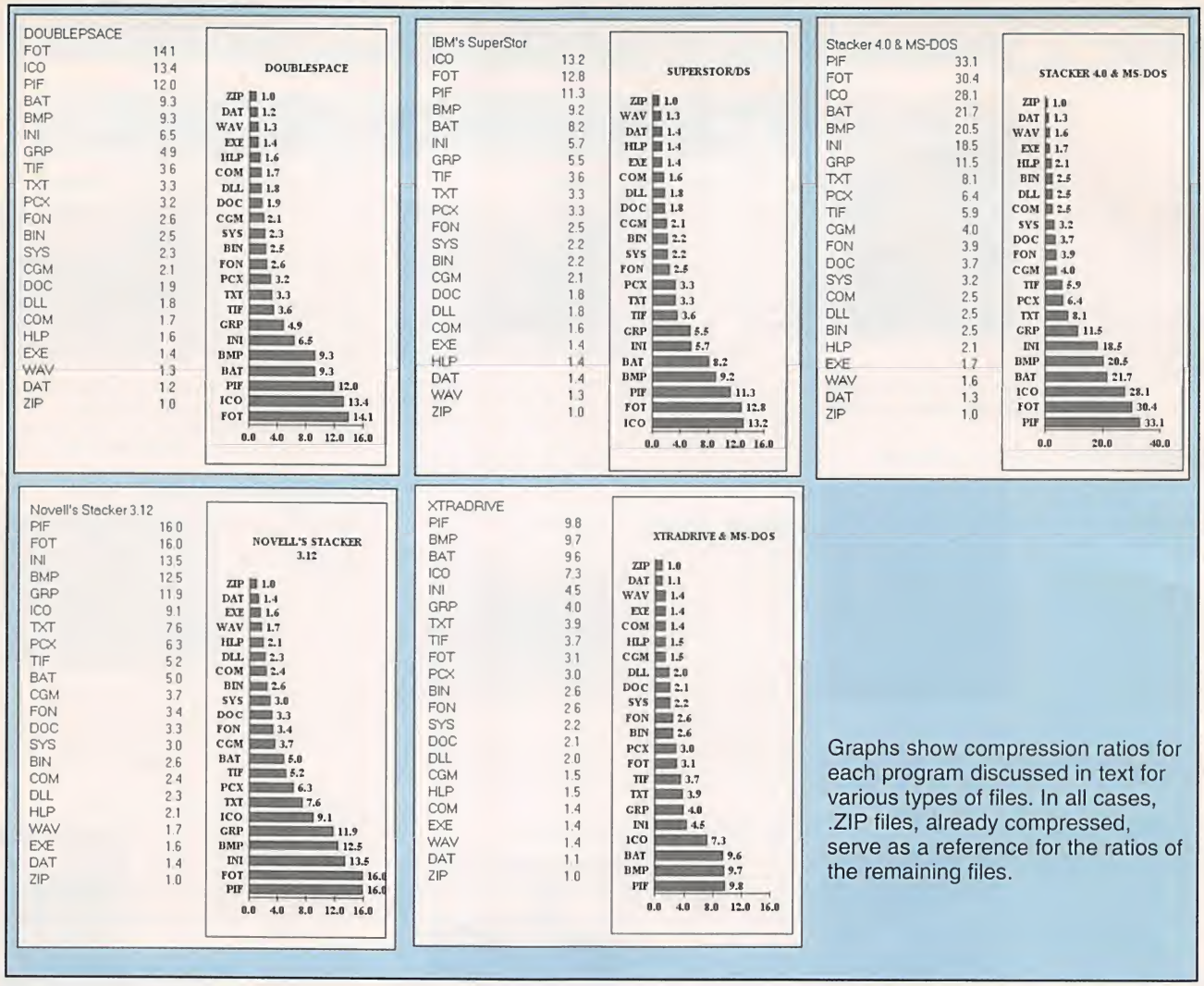
City _____ State _____ Zip _____

MC/VISA/AMEX/Discover # _____ Expires _____

Form of payment: ☐ MC ☐ VISA ☐ AMEX ☐ Discover ☐ Check ☐ Money Order

Please mail your orders to:

CQ Communications, Inc., 76 North Broadway, Hicksville, New York 11801-9962



Graphs show compression ratios for each program discussed in text for various types of files. In all cases, .ZIP files, already compressed, serve as a reference for the ratios of the remaining files.

the BIOS and loads before DOS. Also, unlike the other compression programs, *Xtradrive* doesn't create a large compressed volume file, such as DBLSPACE.000 or STACVOL.DSK. Instead two usable drives are created and the .INI file, typical of the other programs, isn't necessary.

Batch Testing

In testing these programs, I included the results for uncompressed drives. Write-caching is employed with each operating system. Notice from the charts that Novell DOS is the fastest of the operating systems and, consequently, *Stacker* 3.12 is faster in many cases, especially with uncompressed file copying, than the other programs. Caching is consistent on each compressed drive.

The compression programs were tested in their default installation form. That is, no tweaking was done, with the exception of *Xtradrive*, which provides a cache that can run concurrently with other disk-caching modes. In *Xtradrive*'s case, I set up a write-cache of two blocks in expanded memory.

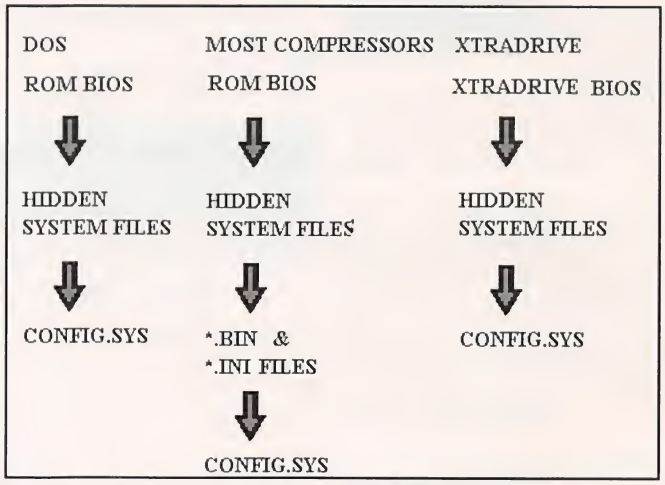


Diagram illustrates what occurs when loading DOS versus loading compressorss. Note that *Xtradrive* works differently from the other compressors.

In both my uncompressed and compressed file copy tests, I wanted to emulate typical user chores. For uncompressed file copying, I created a 2M-byte RAM drive and ran a batch

file that copies a small assortment of files and itself to a directory on the compressed drives (also, to uncompressed drives as the baseline), amounting to a total of 745,219 bytes. The breakdown of bytes includes:

.EXE	422,080 Bytes
.COM	103,633 Bytes
.PCX	25,880 Bytes
.HLP	187,574 Bytes
.TXT	5,969 Bytes
.BAT	83 Bytes

An 87-byte file that records consumed time is also written to the drive.

For my uncompressed-file tests, I first recorded the time required to copy the files in their uncompressed state to three uncompressed operating systems. The files included a mix of four of the following types:

.EXE	2,690,434 Bytes
.COM	172,777 Bytes
.TXT	133,307 Bytes
.XLS	84,218 Bytes

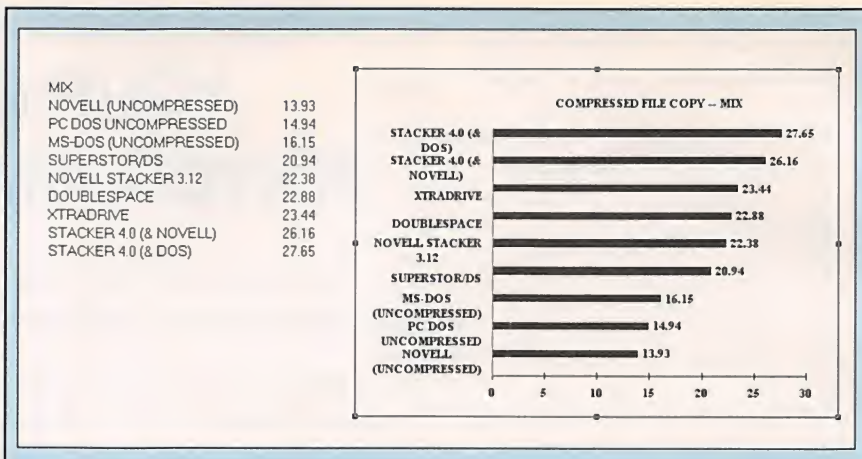
Each has an associated batch file that's also copied, and a timer text file is also written. Consequently, each batch file copies five files and writes a text file. Likewise, when the entire mix is executed, 21 files are copied and the additional text file written.

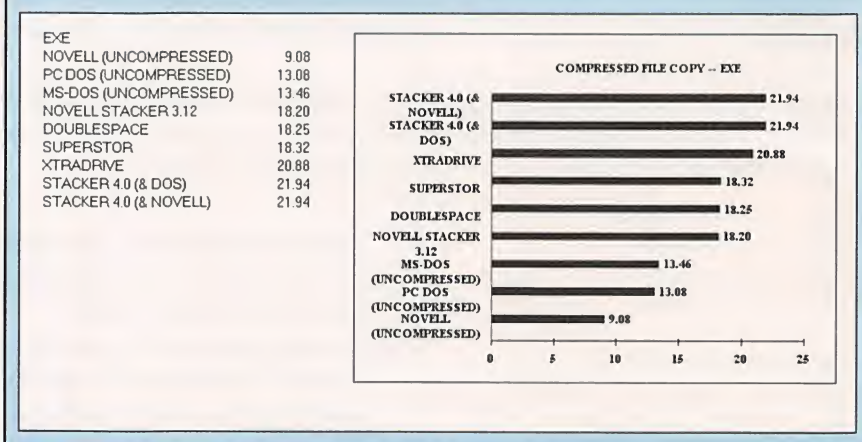
After running these tests, I ran Stac's tune utility (no other program offers an equivalent) included with both *Stacker* versions. Or is it? Though a tuner definitely exists in Version 4.0 and speeds up the *Stacker* drive, choosing tune during Novell compression setup made no difference in performance, nor was there a tuner file created or referred to in Dosbook, Novell's on-line help.

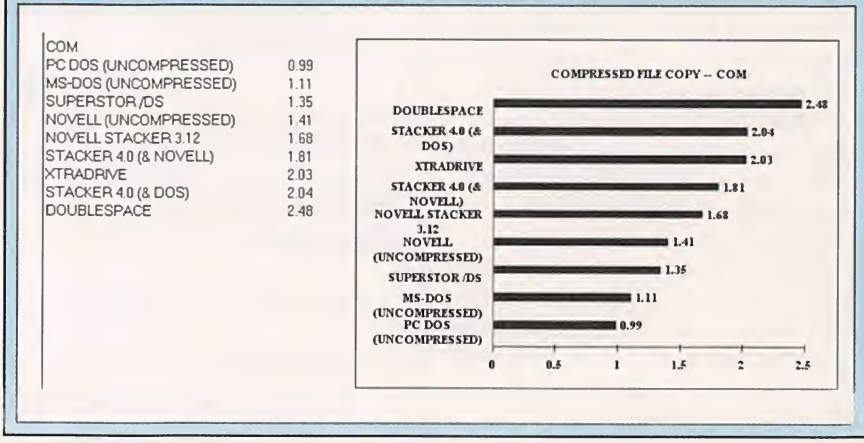
Handy Utilities

The most-notable paradox of transparent disk compression is the necessity to provide maintenance and reporting tools that are obvious, readily accessible and easy to use. *Stacker* 4.0 offers more such tools, in both DOS and *Windows*, than any of the other programs. Programs like *Xtradrive* provide fewer tools, none of which automatically create icons and buttons in *Windows*. For now, IIT asserts that transparent compression ought to remain transparent.

There's a good deal of validity to





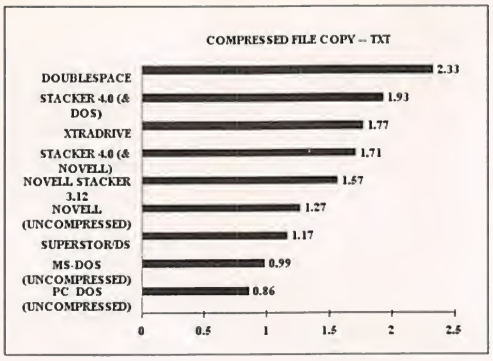


These graphs show time in seconds required to copy various types of files to a compressed volume file. Entries followed by (uncompressed) serve as references. The uncompressed FIle Copy graph is a composite of the other five graphs.

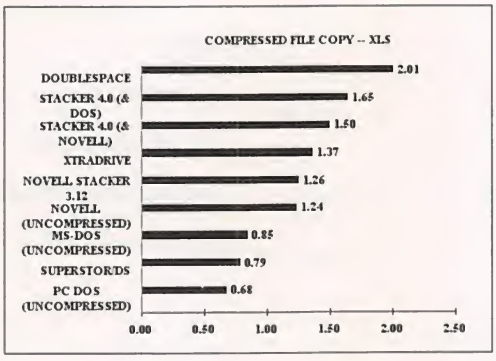
IIT's concept, but *Stacker* in its *Windows* toolbox makes reporting compression ratios, for instance, a snap for the curious. Other programs, also offer ratio reports by executing variations of the DOS DIR command: X DIR, DIR/C. Even *Stacker* offers SDIR /C but goes a bit a further in providing DOS reports. Curiously, Novell *Stacker* reported an overall compress ratio of 2.2:1 (see chart), but its own setup program revealed a 397.5M compressed drive, which is somewhat less than even a 2:1 ratio.

Finding ratios might satisfy user curiosity or help determine how efficiently a program compresses, but utilities that fix faulty compressed drives are far more important. *Xtradrive*, through its VMU, will analyze simple problems and run a thorough surface check to tackle tougher ones. (Programs like DOS's CHKDSK and Norton Disk Doctor can also be run

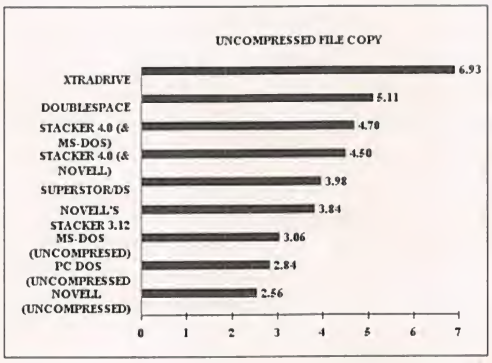
TXT	
PC DOS (UNCOMPRESSED)	0.86
MS-DOS (UNCOMPRESSED)	0.99
SUPERSTOR/DS	1.17
NOVELL (UNCOMPRESSED)	1.27
NOVELL STACKER 3.12	1.57
STACKER 4.0 (& NOVELL)	1.71
XTRADRIVE	1.77
STACKER 4.0 (& DOS)	1.93
DOUBLESPACE	2.33



XLS	
PC DOS (UNCOMPRESSED)	0.68
SUPERSTOR/DS	0.79
MS-DOS (UNCOMPRESSED)	0.85
NOVELL (UNCOMPRESSED)	1.24
NOVELL STACKER 3.12	1.26
XTRADRIVE	1.37
STACKER 4.0 (& NOVELL)	1.50
STACKER 4.0 (& DOS)	1.65
DOUBLESPACE	2.01



TIMER.BAT	
NOVELL (UNCOMPRESSED)	2.56
PC DOS (UNCOMPRESSED	2.84
MS-DOS (UNCOMPRESED)	3.06
NOVELL'S STACKER 3.12	3.84
SUPERSTOR/DS	3.98
STACKER 4.0 (& NOVELL)	4.50
STACKER 4.0 (& MS-DOS)	4.70
DOUBLESPACE	5.11
XTRADRIVE	6.93



on an *Xtradrive* disk, but Scandisk will fail, as it will with all of the other programs.) DoubleSpace (MS-DOS 6.2) uses Scandisk to detect and fix cluster, FAT and surface problems. Checking and repairing *SuperStor/DS*-compressed disks is accomplished through its DOS-based Ssutil and Rtool. *Stacker* 4.0 offers its fairly thorough Check program, while *Stacker* 3.12, the weakest program in terms of repairs utilities, relies primarily upon CHKDSK.

Though not to the extent of, say, a corrupt FAT or lost clusters, file fragmentation, can also become a problem. When too many files become fragmented, a disk may be unable to store more files when there's actually more space remaining. The problem here is that when a compressed file is split into pieces and later modified, it may no longer fit into the same space. Stac products break up the cluster and

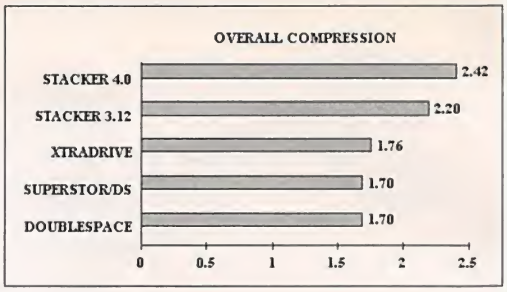
store it in smaller holes, so to speak, while other products rely on a defragmentation program to solve the space problem.

Programs such as MS-DOS and PC DOS DEFRAG, and Novell's DISKOPT reclaim free space while they optimize files. IIT provides a separate utility for reclaiming space, in addition to its Xdefrag defragger. *Stacker* 4.0 goes a bit further in that it re-compresses as it optimizes.

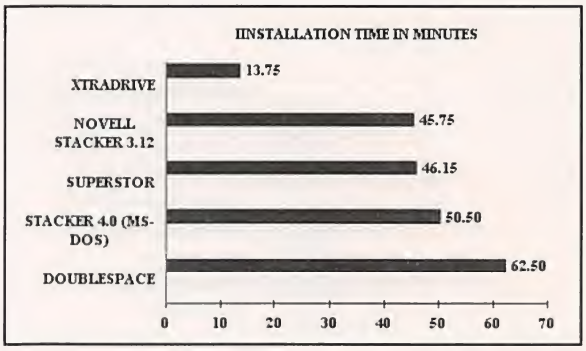
Most of these compression programs will also allow you to increase or decrease the size of a compressed drive, with the exception of *Xtradrive*. When *Xtradrive* is first configured, you're pretty much stuck with a ratio of 2:1. Should the data support better than 2:1 compression, the higher selection, 3:1 for example, must be chosen. Xadjust can then be used if down-sizing is necessary.

No compression utility would be complete without a utility that permits its removal. All of the programs here include one. (MS-DOS 6.0 doesn't.) Each performs removal effectively

DOUBLESPACE	1.70
SUPERSTOR/DS	1.70
XTRADRIVE	1.76
STACKER 3.12	2.20
STACKER 4.0	2.42



Graph shows overall compression ratios for various compressors. *Stacker* gives back the most drive space at a 2.42:1 ratio, Doublespace and *SuperStar/DS* the least at 1.70 :1 ratio.



Graph shows times in minutes it takes to install disk compressors discussed in text. *Xtradrive* is fastest at 13.75 minutes, Doublespace is slowest aat 62.5 minutes.

and requires about the same amount of time—even *Xtradrive*, which compresses files quicker than any other program—depending upon the level of fragmentation but require some housecleaning.

Naturally, before removing a compressor, you must have a valid backup of your hard disk's programs and files if you expect to save data in excess of the drive's physical size. Because of the unique strategy of creating its compressed drives, *Xtradrive* requires you to back up only D:, as its data will be destroyed. Drive C: will be uncompressed, too, but its compressed and uncompressed size is the same. *Xtradrive*'s device driver will, of course, be removed, as will the hidden file IITV3.VOL. But changes made during installation to the *Windows* SYSTEM.INI file remain. So, too, remains the *Xtradrive* directory—a typical remnant, the directory, as *Stacker* 4.0 leaves its own directory.

In both of its iterations, *Stacker* deinstallation leaves ghosts of itself in *Windows*. In Version 4.0, the Toolbox remains in Program Manager and in File Manager. Likewise Novell's 3.12 and DoubleSpace, leave traces of themselves in File Manager. Almost no hint is left of the *SuperStor/DS* installation.

Though hardware-wired compression that can take advantage of VLSI technology is in the works and memory compression are possibile, I'd like to see more companies involved in software-based compression. Renewed competition, after this latest shake-out, can only result in more products, which means, of course, better ones. ■

Products Mentioned

Stacker 4.0, $149
Stac Electronics
Tel.: 800-522-7822

DOS 7, *Stacker* 3.12, $99
Novell
Tel.: 800-453-1267

Xtradrive, $79.95
IIT
Tel.: 800-223-8488

PC DOS 6.1 *SuperStor/DS*, $189
IBM
Tel.: 800-346-6672

By Fred Eady

Getting to Know the PIC16C71 Microcontroller

A tutorial on this improved microcontroller and a low-cost programmer for it

After learning in the May/June issue how to program and use the PIC16C5X series of microcontrollers in your own projects, you'd think that life could not get any better than this, but it does. In this second "how-to" installment on the PIC, I give you a close-up look at the PIC16C71 microcontroller, an improved version of the processor core used in the low-cost PIC16C5X family I described last time. After discussing the theory, I'll show you how to

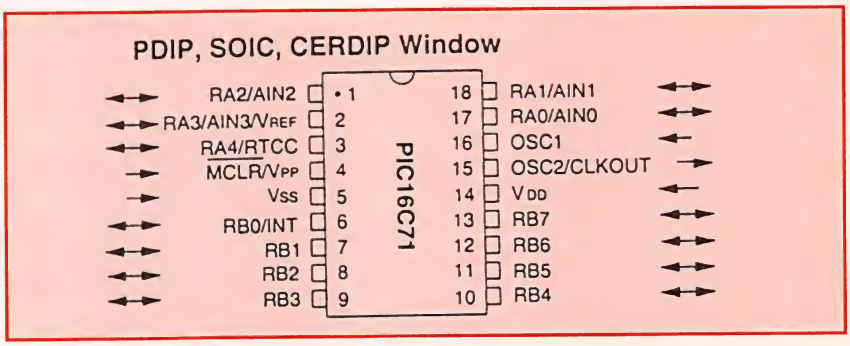


Fig. 1. Pinout details for PIC16C71. (Courtesy Microchip Technology Inc.)

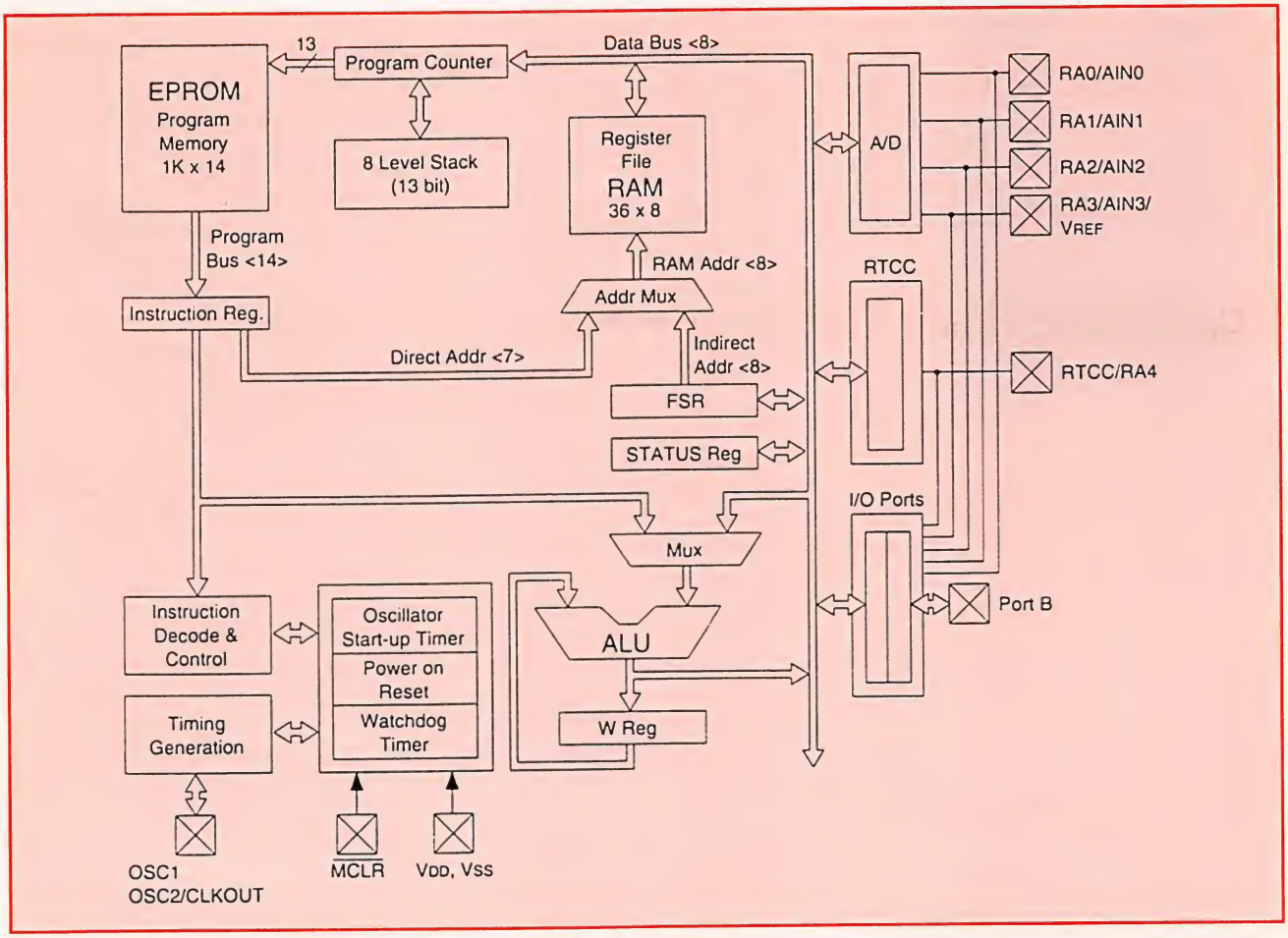


Fig. 2. Block diagram of dual-bus PIC16C71 (Courtesy Microchip Technology Inc.)

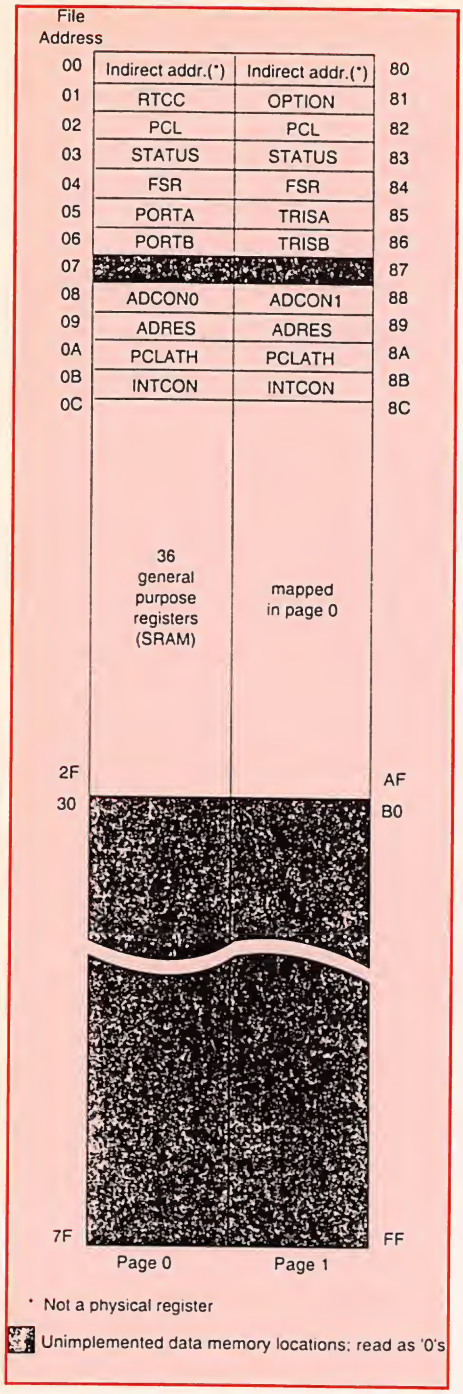


Fig. 3. Data memory map for PIC-16C71. **(Courtesy Microchip Technology Inc.)**

build an inexpensive (at $49, "cheap" may be a better word) programmer for this device.

Since the architecture of PIC16C71 is designed along the lines of the PIC-16C5X series, knowing how to write programs for either of these PIC series devices pretty much means that you can write programs for all of them. In this installment, I discuss the differences between the PIC16C5X and PIC16C71 devices you'll encounter when using the PIC16C71 in your own designs.

The PIC16C71 Microcontroller

The eight-bit PIC16C71 CMOS microcontroller is a 1K X 14 EPROM-based device with an on-chip analog-to-digital (A/D) converter. Like its cousins in the PIC16C5X series, the PIC16C71 contains an advanced RISC-like architecture. The instruction set for the PIC16C71 consists of 35 14-bit instructions that behave much like the PIC16C5X instructions. The entire instruction set is listed in Table 1.

Most of the instructions execute within a single 250-ns processor cycle (with a 16-MHz clock), program branches being the exception, using only two processor cycles. The very high performance attained by the PIC-16C71 series can be attributed to instruction pipelining, a rich internal register set (48 addressable registers) and separate instruction and data memory. This simply means that the PIC16C71 employs what's commonly known as Harvard architecture.

Harvard architecture is register-file-based, with a separate bus and memory space allocated for instructions and data. "Register-file-based" simply means that all program-controlled objects—such as I/O ports, memory locations and timers—are physically implemented as hardware registers. Most likely, the personal computer you use on a daily basis uses what's termed as Von Neuman architecture. The PIC16C71 coupled with Harvard architecture results in using half as much physical code and four times faster execution than is the case with other eight-bit microcontrollers with which it competes.

The PIC16C71 is available in an 18-pin CERDIP EPROM package that has a transparent window to permit erasure and re-use and as an 18-pin OTP plastic DIP device that isn't erasable and can be programmed only once. PIC16C71 OTP parts, just like the PIC16C5X OTP parts, are typically plastic-DIP, less-expensive items and usually find their way into thoroughly tested and stable designs in which no future code changes are apt to occur. PIC16C71 OTP devices cost on an average of about $12 each in single pieces, while the erasable version sells for around $25. SOIC packaging is also available for those of you who have the tools to apply it. In Fig. 1 is shown the pinout diagram for the PIC16C71.

The PIC16C71's data memory (RAM) bus is eight bits wide, while its program memory (EPROM) bus is 14 bits wide. The Harvard dual-bus configuration lets the PIC perform high speed bit, byte and register operations. Harvard architecture also inherently permits overlapping instruction execution. This overlapping of instruction-execution cycles is known as pipelining, which is the simultaneous execution of the current instruction as the next instruction is being read from program memory. Traditional Von Neumann architecture must fetch instruction and data information over a single shared, or multiplexed, bus, thereby eliminating the ability to overlap instruction fetch and execution. A block diagram of the dual-bus PIC16C71 is shown in Fig. 2.

Register File Concept

All PIC16C71 program objects are actually implemented as physical registers within the PIC itself. To gain a better understanding of how the PIC-16C71 hardware works requires a more in-depth look at the PIC register file concept. As I step you through the registers that comprise the PIC16C71 devices, refer to Fig. 3.

Begin with the Operational Register File, which contains a means for indirect data addressing (f0), real-time clock/counter (f1), program counter (f2), status word register (f3), file select register (f4) and I/O registers (f5 and f6). Because the PIC16C71 contains an on-board A/D converter, ADCON0 is implemented and is responsible for A/D process control. As you can see in Fig. 3, there are quite a few more registers implemented within the PIC16C71 than were implemented in PIC16C5X devices to support the enhanced features the PIC-16C71 provides. Let's take a look at the PIC16C71 register stack

• **f0.** Indirect Data Addressing Register f0 isn't physically implemented. f0 uses the contents of the File Select Register (FSR), or f4, to indirectly select any one of the available 48 file

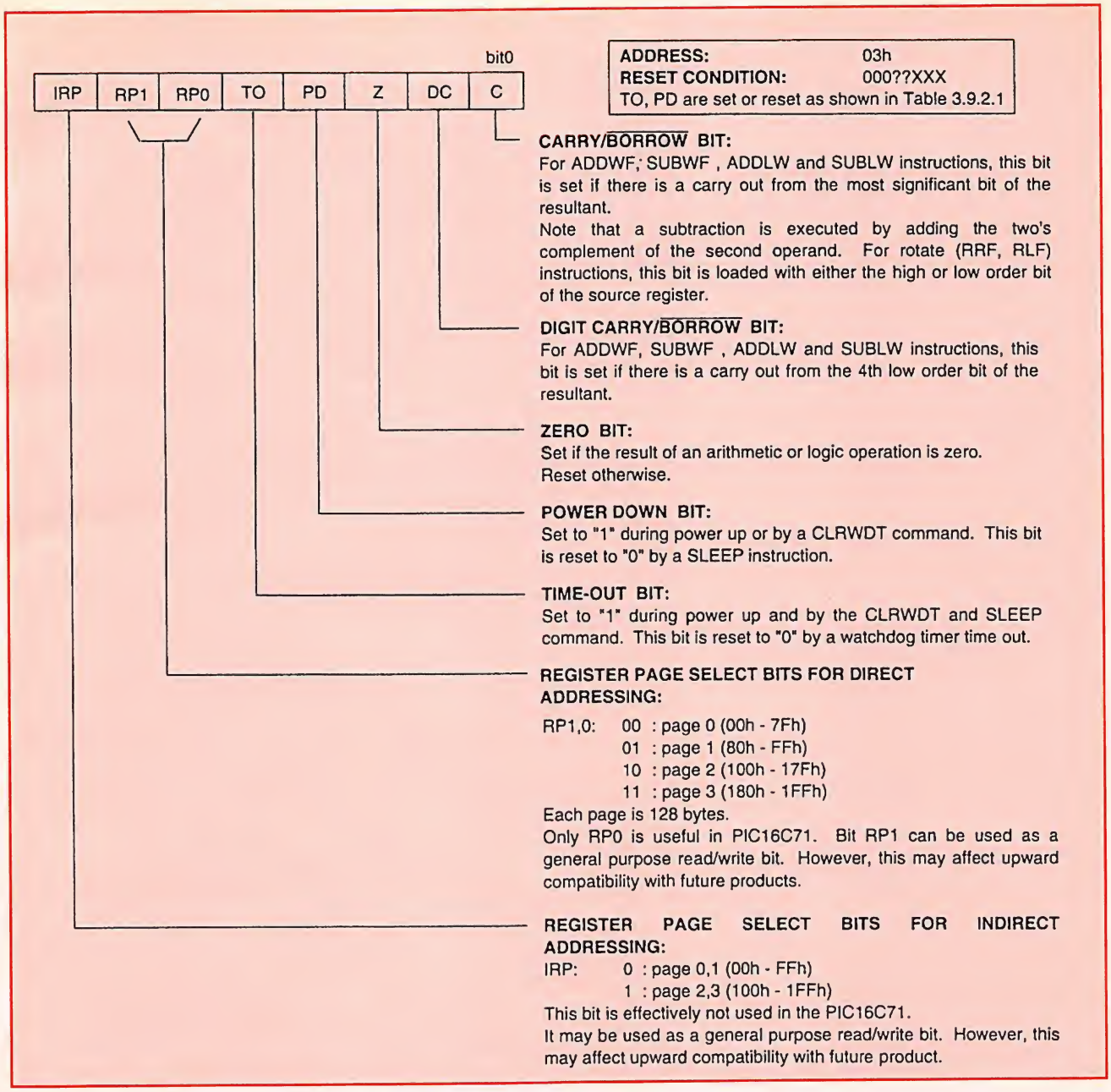


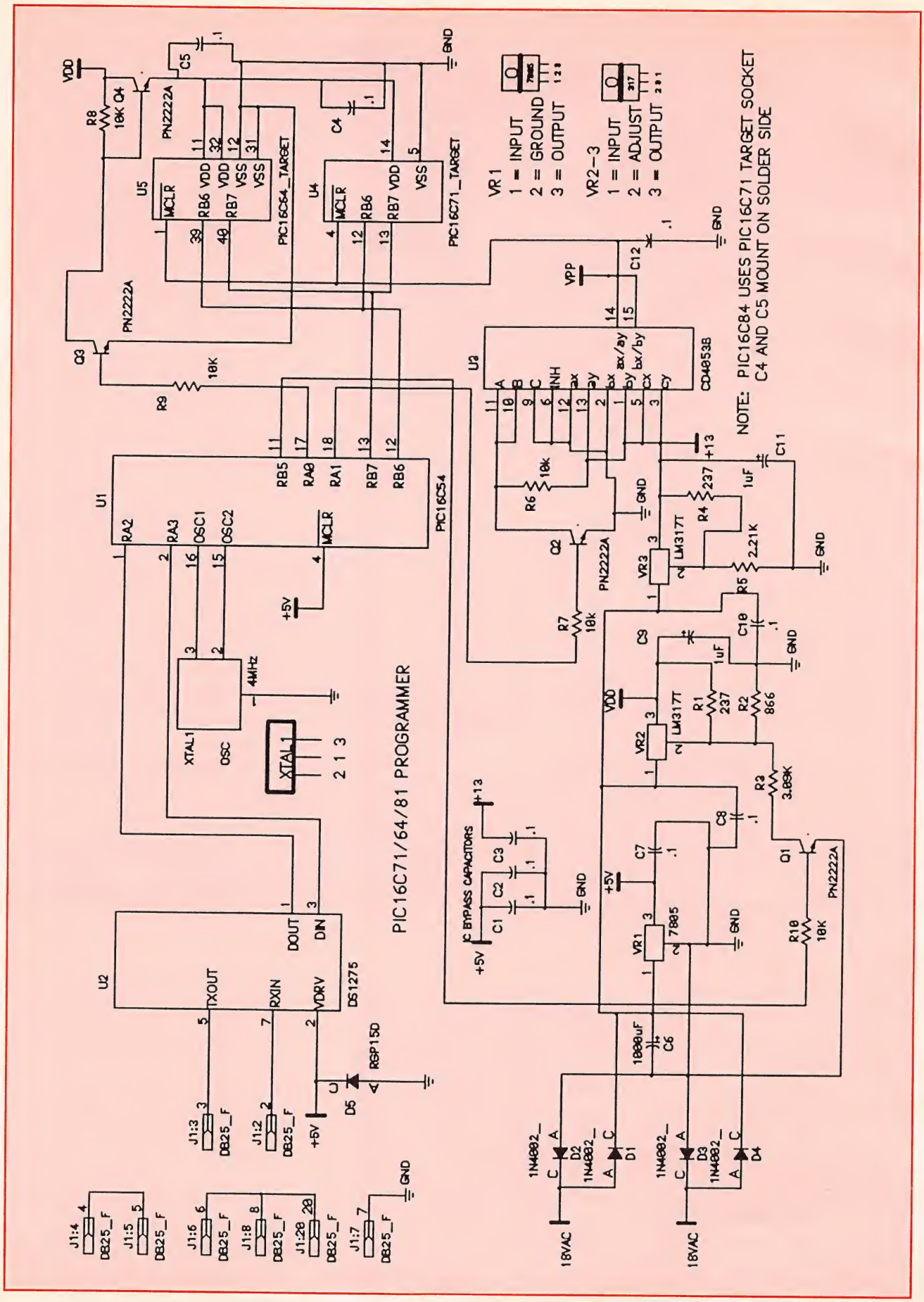
Fig. 4. Details of PIC16C71's status register. (Courtesy Microchip Technology Inc.)

registers for use as a data register or pointer register, depending upon the intent of the instruction that called f0. Register f0 is most useful as an indirect address pointer.

• **f1.** Real-Time Clock/Counter f1 can be read from and written to just like any other register. The RTCC can also be incremented by an external signal applied to the RTCC pin or by the internal instruction clock. The obvious applications that would involve the RTCC are event counting and time measurement. The RTCC can also be prescaled, using the PIC's internal programmable prescaler. The PIC16C71 brings interrupt capability to the PIC family, and the RTCC employs a scheme to generate an interrupt on an overflow from 0FFh to 00h. This sets the RTIF bit that must be cleared under program control.

• **f2.** Program Counter (PC) f2 is used to generate addresses for EPROM cells that contain the 14-bit user-written program instruction words. The low byte, PCL (register 02h), is capable of being read and written. The high byte, PCH, isn't directly accessible. Rather, it uses the PCLATH register for write access. PCLATH is essentially a holding register for the upper byte of the PC during instructions that alter the program counter, such as CALL and GOTO.

• **f3.** Arithmetic status of the ALU (carry bit, zero bit, etc.), RESET status and page-preselect bits are contained within Status Word Register Arithmetic f3, which is comparable to the PSW (Program Status Word) found in most other microprocessors. Register f3 provides two general-purpose read/write bits that are reserved for future use but can be freely used by the pro-


PIC16C71/64/81 PROGRAMMER
NOTE: PIC16C84 USES PIC16C71 TARGET SOCKET
C4 AND C5 MOUNT ON SOLDER SIDE
VR1
1 = INPUT
2 = GROUND
3 = OUTPUT
VR2-3
1 = INPUT
2 = ADJUST
3 = OUTPUT
PIC16C84_TARGET
PIC16C71_TARGET
PIC16C54
CD4053B
DS1275
LM317T
PN2222A
7805
4MHz
XTAL1
I/C BYPASS CAPACITORS
18VAC
1N4002
RSP15D
DB25_F

PARTS LIST

Semiconductors
D1 thru D4—1N4002 rectifier diode
D5—RGP-15D Schottky diode
Q1 thru Q4—PN2222A transistor
U1—PIC16C54 (programmed—see text)
U2—DS1275
U3—CD4053B
U4—PIC16C71 (target)
U5—40 pin ZIF socket
VR1—7805 regulator
VR2,VR3—LM317T regulator

Capacitors
C1 thru C5,C7,C8,C10,C12—0.1-µF, 50-volt monolithic
C6—1,000-µF, 35-volt electrolytic
C9,C11—1-µF, 25-volt tantalum

Resistors (1/4-watt, 1% tolerance)
R1,R4—237 ohms
R2—866 ohms
R3—3,090 ohms
5—2,210 ohms
R6 thru R10-10,000 ohms, 5% tolerance

Miscellaneous
XTAL1—4-MHz ceramic resonator
18-volt, 1-ampere transformer; printed-circuit board; DB-25 connector; 18-pin ZIF IC socket; 40-pin ZIF IC socket; sockets for U1, U2 and U3; hookup wire; solder; etc.

Note: A kit of parts, including programmed PIC-16C54, all components and pc board but *not* ZIF sockets, is available from E D Technical Publications, PO Box 541222, Merritt Island, FL 32954-1222 for $49.95. Also available is the pc board for $25 postage paid. Visa and MasterCard accepted. Add $7.50 S&H per full kit order. Florida residents, please include state sales tax.

DOS-format software for the PIC16C71 is available on 3 1/2" floppy disk for $10 postpaid by writing to E D Technical Publications at theabove address or by dialing 407-454-3198 to download it from my BBS. E D Technical Publications technical assistance, fax and voice-line telephone number is 407 454-9905. All Microchip parts can be ordered from Digi-Key Corp. by dialing 1-800 DIGIKEY, and all Dallas Semiconductor parts can be ordered from Dallas Semiconductor by dialing 1-800-3366933.

grammer. Power-down and time-out bits used by the Watchdog Timer (WDT) and sleep instructions are also held within f3. Figure 4 helps in understanding the bits that comprise f3.

• **f4.** File-Select Register f4, or FSR, is used in conjunction with Indirect Data Addressing Register f0 to indirectly select one of the available file registers. In indirect addressing mode, eight bits plus the IRP bit can be used to access memory locations. In direct addressing mode, six bits plus RP0 and RP1 are used to gain access to data in the memory stack. To eliminate excessive page swapping, note that all general-purpose registers are mapped in page 0 and page 1.

• **f5, f6.** I/O Registers Ports A and B f5 and f6, respectively, comprise the I/O Registers for the PIC16C71. Port A is a five-bit I/O register. Port pins RA0 through RA3 are bidirectional, and pin RA4 is open-collector. Direction control of each pin is mapped in control register TRISA, which resides in page 1. A 1 in TRISA sets the corresponding Port A pin to input. The same can be said of Port B and TRISB. TRIS registers weren't physically mapped this way in the PIC16C5X scheme. Port B is an eight-bit I/O port.

These I/O registers, or ports, can be read from and written to like any other registers in the register file and are capable of having related I/O pins placed in high-impedance state for isolation or read operations by simply writing the correct mask into the correct TRIS control register. Any I/O pin can be independently programmed for input, output or bidirectional operation.

In addition, Port A pins RA0 through RA3 are multiplexed with analog input channels AIN0 through AIN3. RA3 does double duty as the optional external voltage-reference pin for the A/D converter, and RA4 works nights as the RTCC external clock input. Two bits within the ADCON1 file register are used to configure the RAX pins as analog or digital.

Once again, interrupts appear in the PIC16C71 logic structure. This time, popping up in Port B. Port B pins RB4 through RB7 can be configured to generate an interrupt when a data input change occurs on these pins. RBIF is set when a change is detected. Combined with the weak pull-ups on these four pins, interrupt capability makes for interesting possibilities in applications in which keyboard wake-up from power down activity is required.

The foregoing doesn't by any means exhaust the registers available in the PIC16C71. You should familiarize yourself with the following registers as well.

• **A/D Result Register.** The purpose of this eight-bit register is to control the analog-to-digital converter operation

← **Fig. 5.** Schematic diagram for a low-cost build-it-yourself Programmer for PIC16C71 microcontrollers.

and power. By setting or clearing the appropriate bits within this register, the programmer can power up or power down the A/D converter, start a conversion, select an input channel and determine conversion speed via clock-rate selection. ADRES holds the result of the conversion.

• **INTCON Register.** INTCON holds the interrupt-enable bits, as well as various interrupt flags. A global interrupt-enable bit can also be found here. Interrupts can be generated from four sources, as follows:

(1) External interrupt from RB0/INT pin

(2) RTCC overflow

(3) A/D end-of-conversion

(4) Data change on RB4 through RB7 pins

Since the PIC16C71 interrupt logic can get to be quite complicated, I won't get deep into it here.

• **General-Purpose Registers.** The second set of registers known, as the General-Purpose Registers, are addressed 0C through 2F hexadecimal. General-Purpose Registers are most commonly used as internal user RAM.

• **Special-Purpose Registers.** To close out our look at the PIC16C71 register file, I'll briefly explore such Special-Purpose Registers as the W, or Working Register, which is essentially an accumulator. W is used heavily for internal data-transfer operations.

The last of the Special-Purpose Registers is the Option Register, which defines prescaler assignment to the RTCC or WDT. The prescaler is shared by RTCC and WDT, and this assignment is mutually exclusive because only one resource can be prescaled at a time. Other bits within the register determine which signal edge RTCC clocks and if the RTCC input signal is internally or externally generated. Interrupt edge select and Port B pull-up-enable bits are also located here.

Although the hardware stack isn't considered a "register," this is a good place to talk about it. Unlike the PIC16C5X devices, which have only a two-level stack, the PIC16C71 is implemented with an 8 X 13-bit-wide hardware stack. This stack doesn't map into any program or data space, and the stack pointer isn't available to the programmer. The lack of stack data availability may imply weakness, but this is a vast improvement over the PIC16C5X devices, in that subroutines can be more effectively used when applying the PIC16C71.

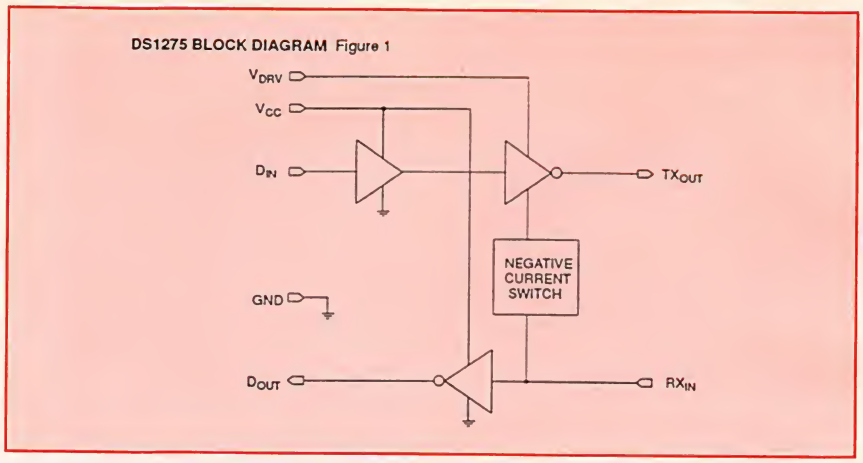


Fig. 6. Block diagram of DS1275. **(Courtesy Dallas Semiconductor)**

Watchdog Timer

The PIC16C71 watchdog timer is used to prevent catastrophic software crashes from stopping a PIC program from executing. The idea behind watchdog timers is to reset the watchdog timer under software control internally or via an external event before the watchdog timer can time-out and generate a processor reset. So, if the program is operating normally, the built-in commands to reset the watchdog timer (CLRWDT) would be executed within specified time limits, eliminating a processor reset. On the other hand, if the microprocessor leaped beyond the existing program or began to loop within the program,

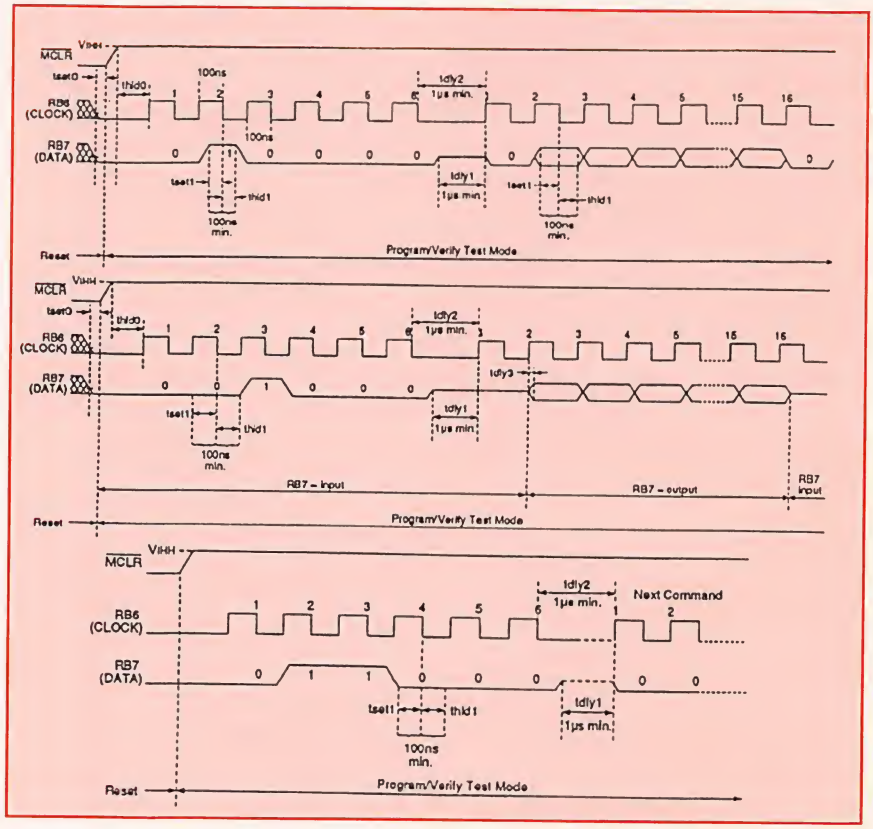


Fig. 7. Timing diagrams for (top) Load Data Command, (center) Read Data Command and (bottom) Increment Address Command programming specification for PIC16C71. **(Courtesy Microchip Technology Inc.)**

B. G. MICRO

P. O. Box 280298 Dallas, Texas 75228
Orders Only 1-800-276-2206
Tech Support 214-271-9834
Fax 214-271-2462

VISA MasterCard

IF YOU DON'T SEE WHAT YOU NEED CALL US. 1-800-276-2206

CALL OR WRITE FOR FREE CATALOG. 1-800-276-2206

LCD DISPLAYS

OPTREX 2x16-DMC 1620H-8 Bit ASCII Input. Dim. 3 1/8 x 1 3/4 x 3/8 Char.Height.19"..... **$5.99**

OPTREX 2x20-DMC 20261-8 Bit ASCII Input Dim. 4 9/16 x 1 7/8 x 3/8 Char.Height .19"..... **$7.99**

OPTREX 1 x 16 "Backlit"-DMC16187- 8 Bit ASCII Input Dim. 3 1/8 x 1 3/8 x 9/16 Char. Height .11"..... **$9.95**

OPTREX 1 x 20-DMC 20171-8 Bit ASCII Input Dim. 7 3/16 x 1 5 /16 x 1/2 Char. Height . 42" **$9.95**

OPTREX 2 x 40-DMC 40218-8 Bit ASCII Input Dim. 7 3/16 x 1 5/16 x 13/32 Char. Height .19"..... **$9.95**

VERY EASY TO INTERFACE TO ALMOST ANY MICROPROCESSOR!

COOL IT DUDE!

Finned Heat Sink with Fan. Fits on CPU.

$11.45

DTMF

SSI-202 Decoder	**2.25**
8870 Decoder	**2.25**
5087 Generator	**2.00**
5089 Generator	**1.25**

EPROM SPECIAL

We bought a large quantity of 2708s, 2716s, 2532s, 2732s, 2764s, 27128s, 27256s, and 27512s from a computer manufacturer who redesigned their boards. We removed them from their sockets, erased and verified them, and now we offer the savings to you. Complete satisfaction guaranteed.

Your Choice	
2708.....1/20	10/8.00
2716.....1.75	10/15.00
2532.....2.00	10/17.50
2732.....2.00	10/17.50
2764.....2.00	10/17.50
27128.....2.50	10/20.00
27256.....3.00	10/25.00
27152.....4.75	10/40.00
1 Meg.....8.50	10/77.50

EPROM

8741	7.00
8742	7.00
8748	7.00
8749	7.00
8751H	12.95
8755	7.00

STATIC RAM

2016-2KK8 200 n.s.	1.00
2101-1 - 256X4 500 n.s.	.75
21L02-1 350 n.s.	.65
2102AL-4 L.P. 450 n.s.	.49
2111-1 256X4 500 n.s.	1.00
2112A-2	2.50
2114L-3 1KK4 300 n.s.	.45
2125A-2 1KK1 70 n.s.	1.00
2147 4KX1	1.00
2148	1.00
6116P-4	1.00
6117	1.20
6264	1.40
62256 32KX8	5.00
128KX8	15.00

DYNAMIC RAM

2108-4 8KX1	1.50
2118-4 16KX1-5 Volt	.70
4027-4KX1-260 n.s.	.80
4116-16KX1-250 n.s.	.40
116-16KX1-200 n.s.	.75
4116-16KX1-150 n.s.	.90
4128 Piggyback	2.00
4164-150n.s.	.49 or 9/3.50
4164-120n.s.	1.10
4164-100n.s.	1.40
TMS4416-16KX4-15 n.s.	2.75
4464-150n.s.	1.40
4464-120n.s.	1.45
4464-100n.s.	1.45
4464-80n.s.	1.45
41256-150n.s.	1.25 or 9/9.95
41256-120n.s.	1.30 or 9/10.99
41256-100n.s.	1.30 or 9/10.99
41256-80n.s.	1.30 or 9/10.99
41256-60 n.s.	1.85
1 Meg - 100 n.s.	4.40
1 Meg - 80 n.s.	4.40
414256-80 n.s. 256 x 4	4.60

SIPPS, SIMMS, & CACHE AVAILABLE

8000/80000

8001	5.20	8237	1.90	8088-2	3.25	8257	1.50
8002	2.50	8237-5	2.80	8155	2.25	8259 A	1.85
8010	4.95	8243	1.75	8156	2.25	8259C-5	2.10
8031	2.95	8250	2.95	8202A	8.00	8275	10.95
8032	3.95	(16450)	6.50	8212	1.25	8279	2.25
8035	1.00	(16550)	10.95	8214	2.00	8284	1.49
8036	4.95	8251	1.10	8216	1.25	8288	3.50
8039	1.00	8253-5	1.75	8224	1.25	8287	2.49
8085	1.55	8254	1.80	8228	1.75	8288	3.50
8086	1.55	8255	1.50			8530	3.00
8088	2.20	8255-5	1.75				

LOCAL AREA NETWORK

NETWORK

Little Big Lan

- Peer to Peer LAN to 250 nodes.
- $75 total software cost! No matter how many nodes!
- Use ARCnet, serial, parallel or Ethernet to link your computers.
- Mixed mode routing. Any combination of the above connectors is possible on any given node.
- RAM needed approx. 35-45K.
- Uses DOS version 2 and above, 3.1 and above preferred.
- Print spooling.
- Record locking via DOS SHARE.
- Open network, API provided.
- Runs okay with Windows 3.0.
- Drive A-Z can be redirected to reference any drive on any computer. LPT1-LPT3 can print to any computer.
- "Start small, grow as you grow."

$75.00

LAN CABLE

Another B.G. Micro Exclusive, 25 feet of Ethernet RG 58A/U Coax with a BNC connector, a BNC "T", and a BNC terminator on each end.

No one can beat this price.....$7.95
Additional "T".....$.99

CUSTOM CABLES

Cables also available for Little Big Lan Serial (5 Wire null modem) - $10.00 for first 6 ft. $.25 after 6 ft. (Custom cable non-refundable).

Parallel adapter $1.50

Adapt most 25 pin to 25 pin cables to meet the parallel interface requirements.

Arcnet - $.50 ft. (Twisted pair only)

Ethernet - $.50 ft. (ThinNet RG58)

NETWORK CARDS

- 16 TB Model-complies with IEEE 802.3
- Standards for 10Base-T and 10Base 2
- Works with most popular network softwares including Netware, TCP/IP, Windows for Workgroups, LANTASTIC,
- On-board 16K RAM for multiple-packet buffers
- Four LEDs to indicate link, transmit/ receive, polarity/Jabber, and collision status
- Automatic polarity detection and correction of writing errors
- Jabber function (watchdog timer).
- Novel approved NE 2000 compliant.

$67.99

- NE 1000 available (Call)
- Arcnet available (Call)

SWITCHING POWER SUPPLIES

DELTA Switching Power Supply

Heavy duty switcher - A full 280 watts completely enclosed w/fan - UL and CSA approved

+ 12V @ 7 amps
+ 5V @ 37 amps
- 5V @ .75 amps
- 12V @ .75 amps

Measures:
8 1/2" x 5 15/16" x 7 3/8"

$17.95 + $4.50 shipping

MFM CARD

MFM Hard Drive Controller

6 Bit Western Digital Hard Drive/Floppy Controller. WD1003-WA2 Brand New Full Length.

$17.95

These controllers are getting very scarce.

LINE CORD

6 Ft. 3 Wire Line Cord
IEC on one end AC on the other.
GREAT COMPUTER CORD

$1.59

MONITOR CORD

1 Ft. IEC Female to IEC Male

From monitor to power supply.

$1.49

TERMS: (Unless specified elsewhere) Add $3.25 postage, we pay balance on Orders Under 5lbs. Orders over $50.00 add .85 for Insurance. No C.O.D. Texas Res. add 81/4% Tax. 90 Day Money Back Guarantee all items. All items subject to prior sale. Prices subject to change without notice. Foreign order - US funds only. We cannot ship to Mexico or Puerto Rico. Canada, add $7.50 minimum shipping and handling. Countries other than Canada, add $15.00 minimum shipping and handling.

the watchdog timer reset commands most likely wouldn't be executed in a timely manner, a watchdog time-out would occur and a full blown processor reset would be issued to clear the error condition and, hopefully, the program would again run normally.

The PIC16C71 watchdog timer doesn't require external components and operates on its own internal RC oscillator. The WDT operates even if the main processor clock isn't operational. The typical WDT time-out period is 18 ms. The prescaler can be assigned to the WDT and extend the time-out period to beyond 2 seconds.

Another function of the WDT is to aid wake-up operations during the PIC16C71 sleep mode. The SLEEP instruction puts the PIC into sleep mode. When the PIC16C71 sleeps, very little power is consumed. Sleep mode can be exited on the occurrence of an event, such as activation of a switch or sensor, or via interrupt.

Oscillator Options

Four oscillator options that can be used with the PIC16C71 series of microcontrollers. These are:

XT	Crystal Oscillator
HS	High-Speed Crystal Oscillator
LP	Low-Power Crystal Oscillator
RC	RC Network Oscillator

You can purchase OTP devices with any one of the oscillator configurations pre-programmed. EPROM devices can be programmed to use any of the four oscillator configurations. XT, HS and LP devices need a ceramic resonator, crystal or buffered external clock source to establish oscillation, while the RC configuration requires only a resistor and capacitor. Naturally, the ceramic resonator and crystal oscillator configurations are more-accurate time-keeping devices. However, if precise timing accuracy isn't required, the RC oscillator approach can be used to cut cost and complexity.

Reset Circuitry

PIC16C71 devices use an internal Power-On Reset (POR) circuit in conjunction with Oscillator Start-Up Timer OST to obviate the need for the traditional reset capacitor and resistor, in most situations. To use the POR circuitry, you need only tie the MCLR pin to +5 volts. If the power ramps up slowly or you're operating with a very slow clock speed, the typical RC reset circuit can be used.

Command	Mapping (msb ... lsb)	Data
Load Configuration	0 0 0 0 0 0	0, data(14), 0
Load Data	0 0 0 0 1 0	0, data(14), 0
Read Data	0 0 0 1 0 0	0, data(14), 0
Increment Address	0 0 0 1 1 0	
Begin programming	0 0 1 0 0 0	
Enter Parallel Mode	0 0 1 0 1 0	
End Programming	0 0 1 1 1 0	

Fig. 8. Command mapping (serial operation) details for PIC16C71. (Courtesy Microchip Technology Inc.)

PIC16C71 Programmer

This PIC16C71 Programmer is designed to be simple, cost-effective and easy to build. There are no exotic components, and the printed-circuit board is single sided, with extra-wide traces for ease of assembly. The circuitry of the Programmer is divided into an RS-232 Module; a Power Module; a Processor Module; and a Target Module. Let's look at each of these in turn.

• **RS-232 Module.** Referring to Fig. 5, the 9,600-bps asynchronous interface is implemented by Dallas Semiconductor DS1275 line-powered RS-232 transceiver *U2*. This CMOS device translates RS-232 signal levels to CMOS/TTL levels. To eliminate the requirement for a negative supply voltage, the DS1275 "steals" current from the received RS-232 signal when this signal is in a negative-voltage, or marking, state. After being translated by *U2*, a mark transposes to a logical 1 (TTL high), while a space equates to logical 0 (TTL low).

The PIC16C71 Programmer operates in half-duplex mode, in which RS-232 data travels in only one direction at a time. Thus, if the host is in receive mode, the Programmer is in transmit mode, and *vice-versa*. The host PC should mark (negative voltage) or idle (0 voltage) its transmit line when receiving data from the PIC16C71 Programmer. Most PC serial ports do this. The PC's transmit line is cross-connected to the Programmer's receive line, and this marking state on the PC's transmit line allows the DS1275 to "steal" negative current and swing the TXOUT pin negative when it's necessary to transmit a mark. If the host PC spaces (positive voltage) the transmit line during receive, the DS1275's TXOUT line will be able to swing to ground only during the transmission of a mark. Typically, to most RS-232 receivers any potential of less than 2 volts dc is considered to be a mark. Hence, the DS1275 is capable of working with its RXIN pin in either marking or spacing condition. Figure 6 is a block-diagram representation of the DS1275.

TTL-level data to be transmitted to the host program is supplied to DIN pin 3 of *U2* from pin 2 of PIC16C54 microcontroller *U1* under software control. TTL-level data received from the host program is routed to pin 1 of *U1* from DOUT pin 1 of *U2*. Since the PIC16C54 doesn't contain an internal UART chart, one was emulated in microcode.

RS-232 I/O is supplied by pins 5 and 7 of *U2*, with TXOUT pin 5 being RS-232 transmit data (to the PC) and RXIN pin 7 acting as RS-232 receive data (from the PC). In a standard 25-pin RS-232 DTE configuration, pin 2 of the serial connector is transmit data and pin 3 is receive data. Note that pins 5 and 7 of *U2* are wired so that DTE transmit pin 2 connects with *U2*'s receive pin 7, and DTE receive pin 3 connects to *U2*'s transmit pin 5. Pin 7 of the serial connector provides for a common ground. Note also that pins 4 and 5 and 6, 8 and 20 of *J1* are tied together in a null-modem arrangement that fools the PC's serial port into "seeing" a real modem attached to it.

Schottky diode *D5* prevents DS-1275 latch-up. The DS1275 chip becomes very hot and ultimately destroys itself when latch-up occurs. If +5-volt power is removed from *U2* and the RS-232 transmit line is in a marking (negative) state, a diode within the DS1275 turns on and creates a latch-up condition. Inclusion of *D5*, with a lower clamp voltage than

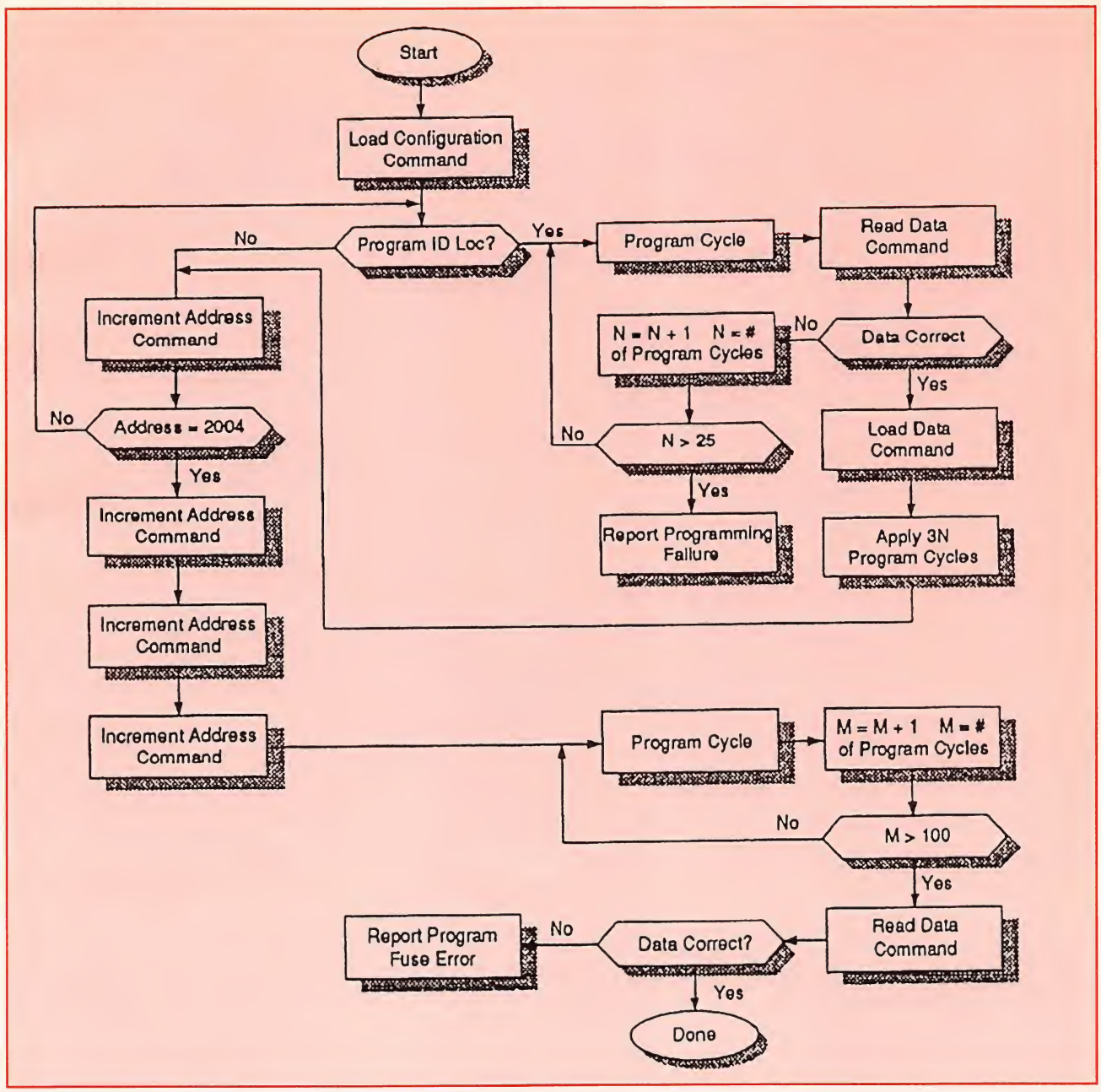


Fig. 9. Serial programming flow chart, PIC16C71 configuration memory. (Courtesy Microchip Technology Inc.)

the internal diode has, prevents the internal diode from turning on, effectively circumventing a destructive latch-up condition.

• **Power Module.** This is nothing more than a good old-fashioned power supply. Diodes *D1* through *D4* and electrolytic capacitor *C6* make up a standard full-wave bridge-rectifier scheme with capacitive filtering. The input to the supply is via an 18-volt, 1-ampere transformer. The +25-volt output from the bridge is routed to voltage regulators *VR1*, *VR2* and *VR3*. Chip *VR1* is a standard 7805 fixed +5-volt regulator, with capacitor *C7* serving as the output bypass. The only load for *VR1* is the PIC16C54.

Input bypass capacitor *C8* provides some stability for LM317T adjustable-voltage regulator *VR2*. Precision resistors *R1* and *R2* provide +5.9 volts on the output pin of *VR2*. This V_{DD} voltage is fed to the target sockets via transistors *Q3* and *Q4* under control of RA0 pin 17 of *U1*. The potential at the emitter of *Q4* is +5.5 volts, unless transistor switch *Q1* is on, paralleling precision resistors *R3* and *R2*. When *Q1* is conducting, the output of *VR2* drops to +4.9 volts, and the resulting potential at the emitter of *Q4* drops to +4.5 volts.

Switchable voltages on the target PIC's V_{DD} pins permit program verification at the minimum and maximum voltage limits of the target PIC. The *Microchip Data Book* recommends this to ensure good programming margins. Capacitor *C9* helps stabilize *VR2*. Capacitor *C11* serves the same purpose for *VR3*. Capacitor *C10* provides input bypassing for LM317T *VR3*, which is setup to deliver +13 volts to CD4053B multiplexer *U3*.

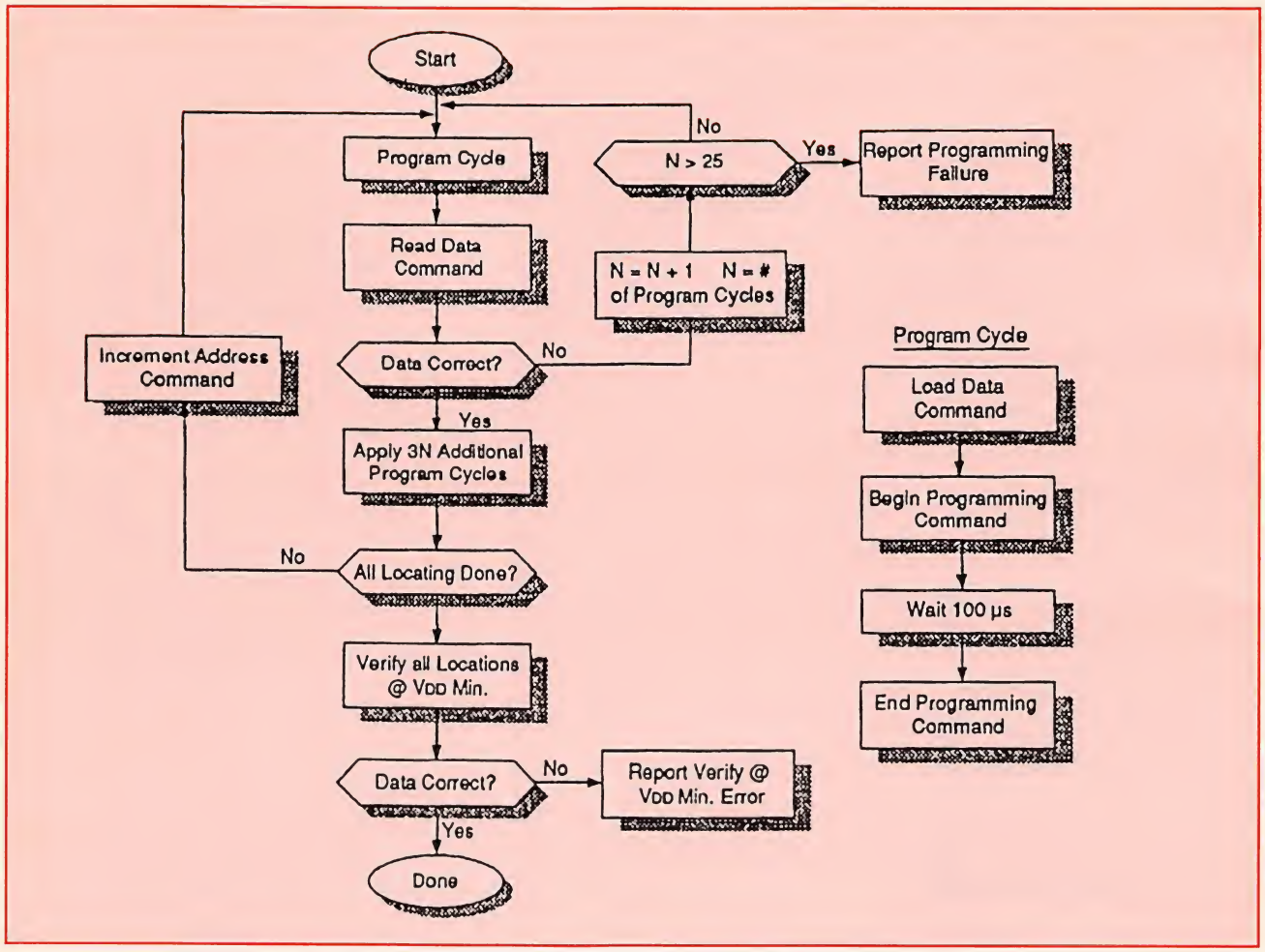


Fig. 10. Serial programming flow chart, PIC16C71 program memory. (Courtesy Microchip Technology Inc.)

The target PIC MCLR (pin 4 of *U4*) line must have 50 to 100 ohms of impedance to prevent target latch-up. This is accomplished by tying together two output pins, ax/ay and bx/by, of the CD4053 such that +13 volts is supplied from the output of *VR3* to the ay/by inputs while the ax/bx inputs are grounded. Note that the cx/cy output isn't used, and both cx and cy inputs are tied to +13 volts. Under control of RA1 pin 18 of *U1*, *Q2* allows +13 volts to to appear at inputs A and B at pins 11 and 10 when it's off. This then selects ay and by pins 1 and 13 as voltage inputs.

At this time, +13 volts is present at *U3*'s V_{PP} output pins 14 and 15. When *Q2* conducts, pins 10 and 11 of *U3* are brought low, ax and bx pins 12 and 2 are selected as inputs and the *U3* output pins 14 and 15 are brought to ground potential. Programming voltage V_{PP} is used to put the target PIC into programming mode. Capacitor *C12* bypasses V_{PP} to provide noise immunity.

• **Processor Module.** This is the "brain" of the Programmer. PIC16C54 *U1* runs at 4 MHz. In that RS-232 and programming-pulse timing are critical, a 4-MHz ceramic oscillator is employed to provide the processor clock.

As you can see, there isn't much to discuss in terms of interfacing *U1* to the transistor switches it controls. Basically, *U1* provides data transfer to the PC host's program via RS-232 link and control of programming instructions to the target PIC. Lines RA2 and RA3 provide interfacing to the RS-232 Module, with RA0 providing on/off power control to the target PIC and RA1 switching V_{PP} between +13 and 0 volts, while RB5 controls V_{DD} voltage (+4.5 or +5.5 volts). Line RB6 is a software-controlled data-clock output, and line RB7 inputs or outputs data to the target PIC in sync with the data clock provided by RB6.

In effect, the waveforms and timings depicted in Fig. 7 are created on the RB6 and RB7 pins of *U1*, using the command structure outlined in Fig. 8. I use the programming format specified by Microchip Technology to program the PIC16C71 serially. Rather than go into a line-by-line code description, Fig. 9 and Fig. 10 describe what the *U1* microcode ultimately is written to accomplish. The fine details are described in Microchip document No. DS30153.

If you wish to obtain the operational details for the Processor Module, you can download the PIC71.A54 file from the E D Technical Publications BBS by dialing at 407-454-3198.

• **Target Module.** While detailing the other modules, I've already described the pin functions for the target PIC sockets. Capacitors *C4* and *C5* bypass the V_{DD} pins, and RB6 and RB7 are target clock and target data I/O, respectively. For now, your only con-

cern will be with the PIC16C71 target socket. In future, I'll provide more software and applications that will utilize other PIC types in target sockets *U4* and *U5*.

Programmer Construction

Begin building the Programmer by fabricating a printed-circuit board onto on which you'll wire together the components, blowing up the etching-and-drilling guide given in Fig. 11(A) to 155% its size. If you prefer not to make your own pc board, you can buy a ready-to-wire one from the source given in the Note at the end of the Parts List.

When you're ready to begin populating the board, refer to Fig. 11(B) . Begin by wiring the power supply circuit. First install *D1* through *D4* and *C6*, making sure you properly orient each of these components. Next, apply 18 volts ac across the two points labeled AC in Fig. 11(B), and use a dc voltmeter or a multimeter set to the dc-volts function to measure the voltage across *C6*. If you obtain a reading of approximately +25 volts here, you've properly wired the diodes and capacitor into place. If not, power down and rectify your wiring error.

Remove power from the board and install *JP1* through *JP5*, *VR1* and *C7*. The metal tab of *VR1* must face *C6* for proper installation, and make sure *C6* is properly oriented. Reapply power to the board and verify that +5 volts is present at the output pin of *VR1*.

When the output of *VR1* checks out okay, install *VR2* and precision resistors *R1*, *R2* and *R3*. Then mount *R10*, *Q1*, *C8*, *C9* and the *U1* socket. This will allow you to toggle the base of *Q1* and note the V_{DD} voltages. Plug the ends of a 2" length of jumper wire into pins 4 and 11 of the *U1* socket to short together these two points and simulate that the PIC is plugged in. Do *not* plug the PIC into the *U1* socket at this time. With the wire in place, apply power to the board and measure from ground (tab of *VR1*) to V_{DD} (tab of *VR2*) and note if you obtain a reading of +4.9 volts. If all is okay, proceed to the next step of assembly. If not, power down and rectify the problem before proceeding.

With power removed, short together pins 5 and 11 of *U1* with the jump-

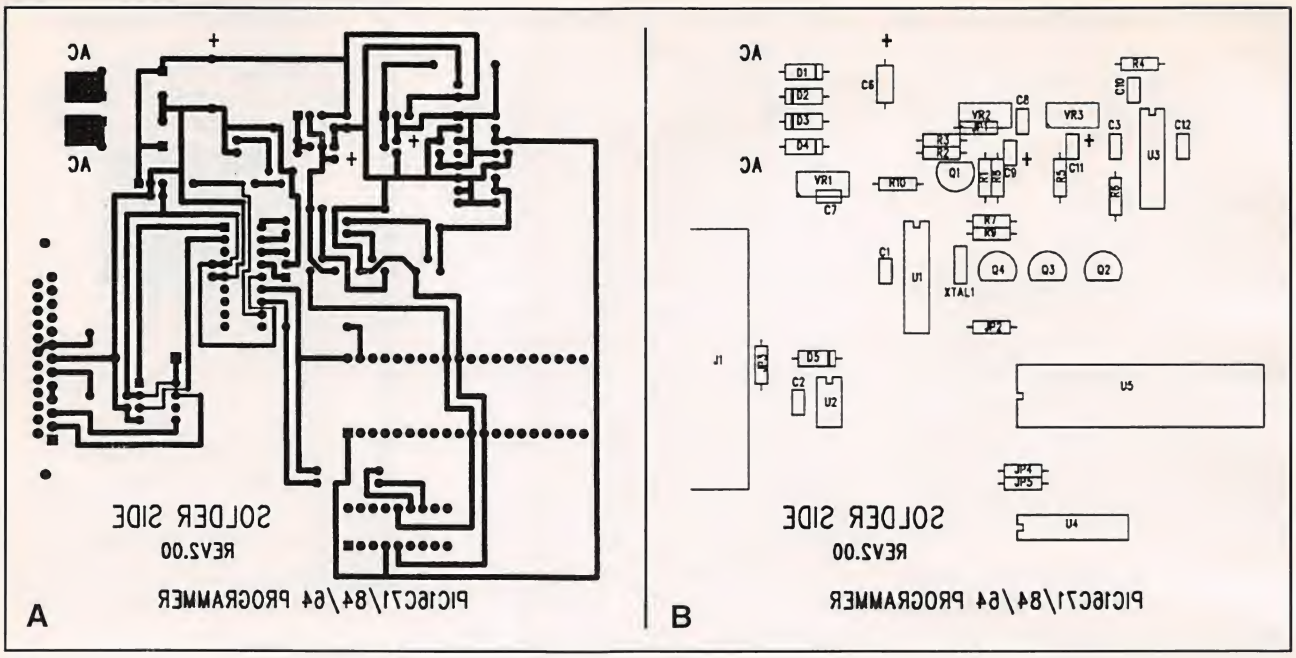


Fig. 11. Shown here are (A) actual-size etching-and-drilling guide for Programmer's printed-circuit board and (B) wiring guide for board.

er wire. Apply power and again measure the voltage on the heat-sink tab of *VR2*. This time, you should obtain a reading of +5.9 volts. Remove power and the jumper wire.

Install and solder into place *C10*, *VR3*, *R4*, *R5* and *C11*. Then reapply power and check for the presence of +13 volts on the *VR3* heat-sink tab. This done, remove power and install *R7*, *Q2*, *R6*, *U3*, *C3*, *C12* and the remainder of the IC sockets, including any ZIF sockets for *U4* and/or *U5*. Plug *U3* into its socket. Use the jumper wire to short together pins 5 and 18 of *U1*, apply power and check the voltage at pin 15 of *U3*. You should obtain a reading of about +13 volts, which shouldn't exceed +13.5 volts or be less than +12 volts. Remove power and short together pin 5 and 18 of *U1*, reapply power and measure the potential at pin 15 of *U3*, which should be 0 volt. Remove power and the jumper.

Next, install *R9*, *Q3*, *R8* and *Q4*. Use the jumper wire to short together pins 4 and 17 of *U1*. Install a 10,000-ohm resistor across pins 5 and 14 of *U4*. Applying power and measuring the potential at the emitter of *Q4* or across the 10,000-ohm resistor should yield a reading of 0 volt. Without the 10,000-ohm resistor across pins 5 and 14 of *U4*, the emitter of *Q4* will float and may read at low random voltages. Install *C4* and *C5* on the *solder* side of the board. For *U4*, install capacitors across pins 5 and 14. For *U5*, install capacitors across pins 11 and 12 or 31 and 32.

Finish up by installing the remaining bypass capacitors. Don't forget *D5* and the 25-pin connector. When mounting the ceramic oscillator, make sure that its center pin is grounded. This device can be mounted in either direction.

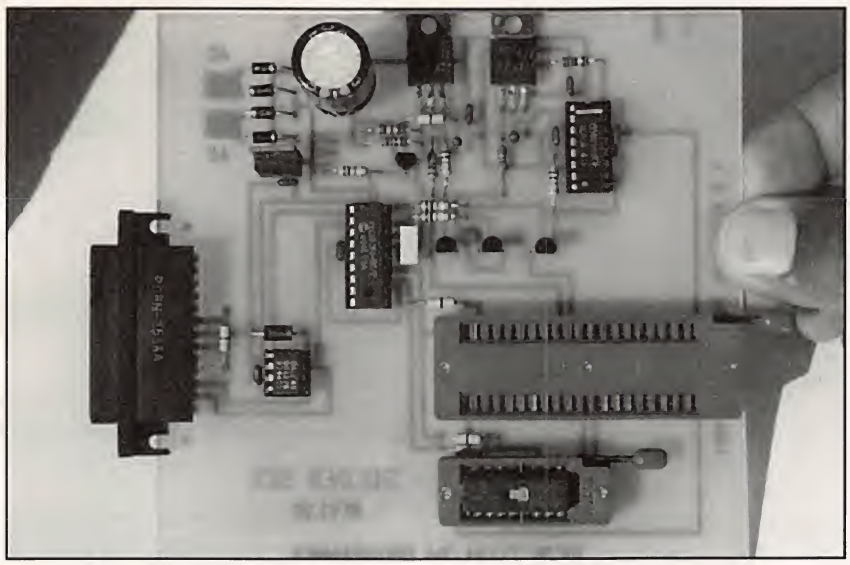


Photo of author's wired prototype of PIC16C71 microcontroller programmer described in text.

Before installing the PIC16C54 and DS1275, use your meter to confirm that +5 volts is present at pins 2 and 8 of the *U2* socket and pins 4 and 14 of the *U1* socket.

Once you're satisfied that all voltages check out, plug the remaining ICs into their respective sockets and recheck the +5-volt points on *U1* and *U2*.

After installing all ICs, apply power. Your Programmer doesn't have to be connected to a PC to obtain the following results: MCLR (pin 4 of *U4*) is 0 volt; target PIC pin 14 of *U4* floating (not greater than 3 volts); target PIC pins 12 and 13 of *U4* are at TTL low level. These signs indicate that *U1* is, in fact, controlling the transistor switches and running the internal program. Pin 15 of *U1* should be oscillating, which indicates that the processor clock is running.

Using the Programmer

Use of the PIC71 terminal program is effortless. Simply type in PIC71, hit Enter and a command-syntax screen with an example entry is displayed on your PC's video monitor. The PIC71 terminal program is designed to sense the direction in which you're going and help you get there. As an example, if you type in PIC71 P, an incomplete program command, and press Enter, an error message informing you that you left out a parameter will be displayed. The correct program command syntax is displayed, and an example program command entry is offered to help you enter the correct command. There's very little left to chance when using a PIC16C71 microcontroller.

To make things even easier, I've included a number of .BAT files to simplify the PIC programming process. For instance, to blank-check a PIC16C71, execute B71.BAT. Likewise, you can use P71.BAT to program a PIC16C71, and R71.BAT to read the same device. You can custom-tailor the .BAT files to match your system's parameters.

All of the software mentioned above is available on the E D Technical Publications BBS (tel.: 407-454-3198). Since the PIC71 program is written in C, the code is easily read and ported. The program inside *U1* is written in standard Microchip assembler and is fully commented. The PIC16C71 Programmer described here uses code that's generated by the Microchip assembler. If you don't already have the Microchip assembler, get a copy of the *Microchip Data Book* or the *Microchip Embedded Control Handbook* (or both). Within the pages of these manuals are instructions as to how to get to the Microchip BBS.

Now all you have to do is connect to your Programmer to a serial port on your PC and start writing PIC16C71 code. If you have questions or need help, just give me a call or shoot me a fax at 407-454-9905. ■

By Hardin Brothers

OS/2: Taking the Plunge

The benefits of moving up to this operating environment are worth the effort

It's advertised as "a better DOS than DOS; a better *Windows* than *Windows*," but I hadn't seen any reason to add IBM's OS/2 to my computer. However, when a client asked me to install OS/2 as a condition of a job, I decided to take the plunge. Although the installation process was long and, at times, frustrating, I've found that OS/2 is a much better computing environment than DOS and *Windows* alone.

Few of the installation problems I encountered were the fault of OS/2. The real problem was preparing my computer for a new operating system. Once this was done, almost everything else went smoothly.

Adding a Drive

The 230M hard drive I had in my computer when I started out was nearly full, and OS/2 requires 20M to 40M at a minimum. It's really more comfortable with 50M or more. So it was time to add a second hard drive to my system.

As I called local computer dealers, looking for the best deal on a 400M to 500M drive, I got conflicting opinions about whether a second drive of a different brand would work with the drive that came with my computer. Luckily, the dealer that had the best price also gave me the best warranty. If the drive didn't work, she said, I could return it for a full refund. The technician also took the time to explain how the jumpers on both hard drives should be set for the dual-drive setup I had in mind.

Installing the second hard drive and getting both working together was no problem. It's a simple matter to set the jumpers, slide the drive into place, attach the data cables and power cable and close the computer's system unit. Then I set the computer's BIOS with the parameters of the new drive.

Since IDE drives don't need low-level formatting, getting the disk ready for use is also quick and easy. You simply run the DOS FORMAT command, and everything is done. My old drive was designated as drive C:, the new drive as drive D:.

OS/2 can be installed three different ways. It can be the only operating system. It can be part of a "dual-boot" system. Or it can be installed as a boot manager. I knew I didn't want OS/2 to be the only operating system on my computer because I'm involved with too many projects that require a pure DOS or DOS-and-*Windows* environment. Even though OS/2 includes its own DOS and *Windows*, I'd never be able to tell whether I was having a problem with a program because of OS/2 or because of the program itself.

"...I found that OS/2 is a better computing environment than DOS and Windows *alone."*

The dual-boot option was tempting. With this system, you install both DOS and OS/2 on the boot partition of the same hard drive. While the computer is running, you choose which operating system you want to use the next time you boot up. The system files and configuration files are copied from a special directory to the root directory, where they're ready for use when you reboot.

I finally picked the Boot Manager system of switching operating systems. To use Boot Manager, you have to repartition your boot drive. The first partition (which is only 1M), contains a program called Boot Manager. You can then create separate boot partitions for each operating system you use. For example, I have my computer set up for two different versions of DOS plus OS/2.

Each time I boot from the hard disk, the Boot Manager screen appears and lets me choose which of the three operating systems I want to use. If I choose one of the two DOS systems, it appears as drive C:. If I choose to boot up with OS/2, which I have stored on an "extended" partition, it appears as drive E:. The new hard drive, which holds most of my applications and data, is always drive D:. This seems like a reasonable plan because I can run any DOS, *Windows* or OS/2 application easily whether I boot up under DOS or OS/2.

My first step, then, was to move *Windows* and all of my applications from drive C: (the original hard drive) to drive D:. Physically moving the files was easy (I'd backed up everything onto tape, just in case of an error), but then I had to make extensive changes to every file and program that contained the name and path of a data file, initialization file or another executable program.

Most of these changes were easy to make with a powerful editor. For example, I loaded all of the *Windows* .INI files into the editor at once and had it do a global search and replace, changing "C:\" to "D:\." I made similar changes to my AUTOEXEC.BAT and CONFIG.SYS files.

The *Windows* Program Manager keeps a separate .GRP file for every group of icons you see on the screen. The .GRP files contain the start-up information for each icon, which is what you see if you select an icon and

then the File menu's Properties option. Part of the information is the path to the application and the path of the working directory.

The normal method of updating .GRP files is to reset the Properties for each icon in each group. This seemed like an awful lot of work. Instead, I opened each .GRP file with a sector editor, searched for each occurrence of "C:\" and changed it to "D:\." This seemed simple and relatively fast. But it didn't work. I found that each .GRP file includes a checksum, and, of course, my changes had changed the checksum for each file. Program Manager started with a completely blank screen after reporting that each group file was invalid. So I had to reload the .GRP files from tape and manually change the values for every icon. That was a slow, boring job.

Once this was done and I had made a few changes to other programs, I had my DOS and *Windows* programs running normally. It was then time to re-partition my hard disk and install Boot Manager and OS/2.

Versions of OS/2

OS/2 2.1 is available on two different kinds of media: 3½" diskettes and CD-ROM. I chose the diskettes, and then found that they must be installed from drive A: only. On my computer, drive A: is a 5¼" drive, while drive B: is (or was at the time) a 3½" drive. So I had to spend a few minutes with the computer's system unit open, changing the floppy-drive cable to switch drives A: and B:. It was an easy job, as was changing the BIOS startup information to record the change in drive types.

Besides media types, you can choose from two different versions of OS/2 2.1. One type, called *OS/2 for Windows*, uses your current copy of *Windows* 3.1 (but not *Windows for Workgroups*) when you want to run a *Windows* application. The price of this version is about half that of "normal" OS/2, which includes its own version of *Windows*, called WIN-OS2.

I guessed *OS/2 for Windows* was the best bet and would make *Windows* applications as compatible as possible with OS/2. It's a good choice, but I found that I had a major drawback on my computer.

The problem with *OS/2 for Windows* is that it must configure *Windows* correctly to make it compatible with OS/2. Normally, this wouldn't be a problem, but I wanted to leave my *Windows* configuration unchanged, since I have it carefully tuned for my hardware and daily work. Also, the manufacturer of my video card could give me no guidance about how to install his OS/2 and *Windows* drivers to work correctly with all modes (DOS, *Windows* and OS/2) available in *OS/2 for Windows*.

"OS/2 is both an operating system and a collection of operating environments."

So I undid the changes OS/2 had made in *Windows*, erased *OS/2 for Windows* from the hard drive and installed the "upgrade" version of OS/2 2.1. In this case, "upgrade" means "add this to any computer that is running any version of DOS."

This version of OS/2 has its own *Windows* support, called WIN-OS2, built in. It doesn't need to use Microsoft *Windows* at all. If you have the disk space, and if you plan to continue running *Windows* from a plain DOS boot, it may be your best bet.

Unless you install OS/2 with the dual-boot system (with both OS/2 and DOS on the same partition), your last important decision will be to decide upon the kind of drive partitions you want to use for OS/2 and its data. OS/2 can use the FAT file system that DOS has always used, albeit with a few small tweaks to support extended filenames and file attributes. It can also use a partition formatted for a High Performance File System (HPFS). The difference is that the HPFS, which is native to OS/2, can do a much faster job of reading and writing data, especially when it's teamed with OS/2's disk-cache program.

If you have a partition with 400M or more of space attached to a fast computer with 12M or more of RAM, HPFS is your best choice. On the other hand, on a partition of 200M with 8M of RAM, there may be little difference. As partition size and available RAM shrink, the FAT file system becomes more and more attrac- tive. On my computer, which has 8M of RAM, OS/2 occupies a partition of just over 200M. I opted to format OS/2's disk space as a FAT partition, in part so I could use *Stacker for OS/2*, which won't work with an HPFS drive.

Once you've made this final important decision, it's time to install OS/2. After booting with the first diskette, you answer a few questions and swap disks when the installation program directs. The process isn't fast (copying and de-compressing files rarely is), but it really is easy.

The final part of the installation program runs while OS/2 displays a short tutorial program. Then the OS/2 Workplace Shell appears, and you're ready to explore this "better DOS than DOS and better *Windows* than *Windows*."

Exploring OS/2

OS/2 is both an operating system and a collection of operating environments. The different environments work together so well that it's easy to forget that they're, in fact, separate.

First, and probably foremost, OS/2 can run Workplace Shell or Presentation Manager programs. These are graphical programs that are similar to *Windows* applications, except that they run in the more-efficient OS/2 environment.

Second, OS/2 includes a complete command-line environment, the [C:\] prompt, which is similar to the DOS prompt but has more-powerful commands available. In addition, the OS/2 command prompt includes the REXX language, a powerful but simple programming language that makes traditional batch files look senselessly weak. REXX is no more difficult to use than the DOS and OS/2 batch file language, but it does so much that there's no need for a simple *BASICA* or *QBasic* interpreter. The OS/2 command-line environment can either use the entire screen or appear in a window on the OS/2 desktop.

Third, OS/2 includes its own version of DOS and can also run other DOS versions. The DOS prompt can appear in either a window or full-screen, much as it appears inside *Windows*. The one real difference is that each DOS prompt can be completely isolated from every other DOS prompt (and every other program) in OS/2. Each can have its own AUTOEXEC.BAT file, for example, its own memory resources (including extended, expanded and upper memory) and its own crash protection. DOS (and

"The flexibility of running* Windows, Windows *applications, DOS, OS/2's command line or OS/2 graphical applications is one of the things that make OS/2 attractive."

Windows) applications can be isolated from each other so that no program can have any effect on other programs. If one crashes, the others continue to operate without any problem.

OS/2 can run *Windows*, either the special version of *Windows* shipped with OS/2 2.1 or your own *Windows* 3.1 if you install *OS/2 for Windows*. This *Windows* will have a Program Manager and File Manager, be able to launch multiple applications and behave just like the *Windows* you're used to.

Finally, OS/2 can run individual *Windows* applications either in *Windows* on the OS/2 desktop or full-screen. In this way, virtually all *Windows* applications can act just like native OS/2 applications.

The flexibility of running *Windows*, *Windows* applications, DOS, OS/2's command line or OS/2 graphical applications is one of the things that make OS/2 attractive. Also, OS/2's ability to keep programs separate generally makes the entire system crash-proof. If one program is badly behaved, others will continue to run.

This Isn't Program Manager

The other attractive feature of OS/2 2.1 is its Workplace Shell operating environment. At first, the Workplace Shell seems like a close relative of the *Window*'s Program Manager. It contains icons and groups of icons, and when you click on an icon, a program runs. But after a little use, you'll find that the Workplace Shell isn't like Program Manager at all. In fact, it's much more powerful and much more enjoyable to work with.

The Workplace Shell desktop is a collection of objects. The objects include folders; files; hardware like the keyboard, mouse, clock, and printer; a spooler; a shredder (for making deletions); etc. Folders can contain other folders, files (both data files and executable programs) and tools. The result is that you can have as much or as little on your desktop as you want to see. And you can have groups of programs within groups of programs, something that's impossible in the Program Manager.

Also, each object on the desktop has a large group of settings associated with it. Some settings are for OS/2 programs, some for DOS or *Windows* sessions or applications and some for folders. By using the settings, you can determine how the object acts, you can edit its icon, you can select how objects inside a folder are displayed and perform other tricks that are impossible in *Windows*. For example, you can copy an object or create a shadow of an object. Both result in a copy of the original icon appearing somewhere else on the desktop, but a shadow points to the original. If you change the settings of the original, the shadow is changed as well.

Finally, the Workplace Shell knows how to shut itself down intelligently. If you choose, it can keep track of its own organization when you shut down your computer. The next time you boot up, the desktop will look the same, the same applications will be open and everything will be as you left it. This is a lot more powerful than Program Manager's attempt to remember the arrangement of groups and icons in its window.

Trying OS/2

I have, of course, had some problems running DOS and *Windows* applications inside OS/2. The difference in types of multitasking, for example, can cause some *Windows* programs to run erratically under OS/2. OS/2 uses "preemptive" multitasking, which means that the operating system takes control away from each application and gives control to the next application whenever necessary. No matter how poorly behaved a DOS, *Windows* or OS/2 application is, it will never be able to hog the entire computer. *Windows*, on the other hand, uses "cooperative" multitasking (for *Windows* applications) and preemptive multitasking for DOS applications. A *Windows* application is expected to give up control when it can so that the next program in line can have a chance to use the computer.

OS/2's form of multitasking is usually considered superior but more difficult to implement correctly. However, it can cause some problems for *Windows* applications that expect to be able to hog the computer once in a while. I've had problems with arcade-style games, which run jerkily under OS/2, but not with any major applications. In fact, some applications seem to run faster under OS/2 than under *Windows*. For example, programs that hog all of *Windows* to print can seem faster under OS/2 because the application and print spooler are forced to share the computer.

Otherwise, I've found OS/2 to be an ideal environment for DOS, *Windows*, and native OS/2 applications. It makes more rigorous demands on my computer, and I'll probably have to add 8M of RAM in my machine to get the most from OS/2. But RAM is a lot less expensive than the regular frustrations of trying to do more with *Windows* 3.1 than it can handle. I've yet to feel that I've met any kind of limits in OS/2 and expect that it will stay on my computer long after I need it to work on my current projects. ■

By Steven Sweet

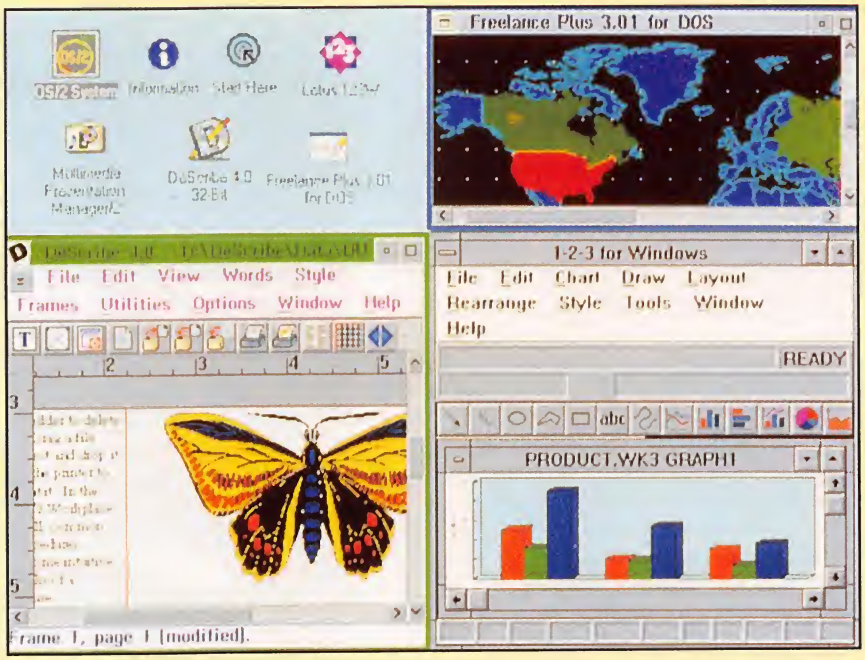
The *Real* Cost of Upgrading to OS/2 2.1

What you need to get the most out of your 368 or 486 computer with OS/2 2.1

If you're like me, you started in microcomputing with an IBM PC or XT computer in the early to mid-1980s. During the past 10 years, you've probably moved up to a 286-, 386SX- and a 486-based PC, and your mouth just waters at the thought of moving up to a Pentium PC. As you tried to keep up with the various enhancements, you've almost certainly discovered that your favorite software has become more demanding of the PC hardware on which you run it, sometimes at the price of speed and ease of use.

Since beginning to use PCs, you've become more comfortable with and dependent upon them while at the same time expecting more from them. Perhaps as a lengthy document is printing, a spreadsheet is recalculating, an image is rendering, a disk is formatting, a file is coming in from an on-line database or a fax is arriving, you'd like to be able to perform another task on your PC during the wait.

To obtain this kind of computing power and flexibility, you need a multitasking operating system like IBM's OS/2 or Microsoft's *Windows NT*. In this article, I'll give you a realistic view of the costs in time and money you'll have to invest when upgrading your PC's operating system to multitasking capability to make your desktop PC more productive. The focus here is specifically on OS/2 2.1.



OS/2 2.1 lets you run DOS, *Windows* and OS/2 applications side by side and still access the Workplace Shell.

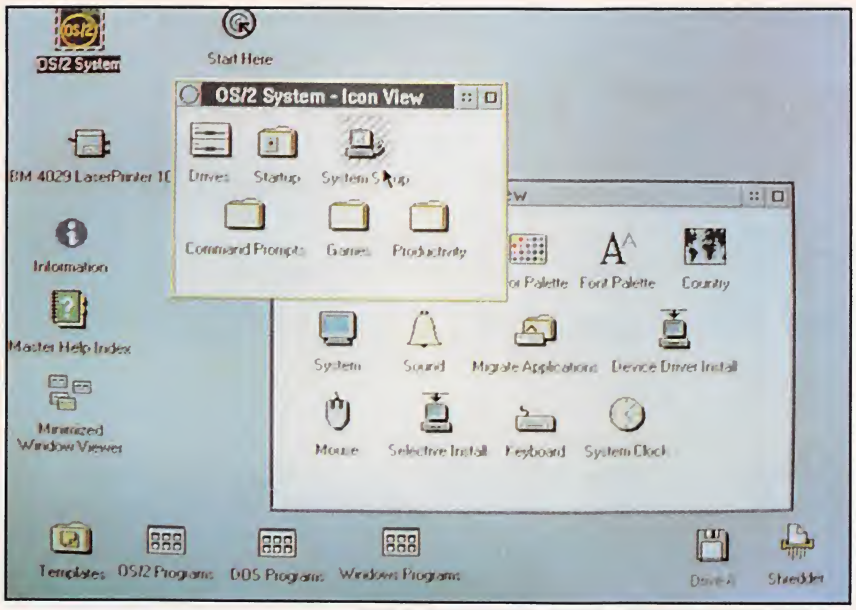
Setting the Stage

Since you purchased your first PC, the prices of newer technology have dropped dramatically. Prices of currently available PCs are at a point where a basic 486DX33 with 4M of RAM, 120M hard drive and VGA monitor costs less than $1,000. A similarly configured 386 PC can go for around $600, and you can pick up 60-MHz Pentium PCs for around $2,000. These machines offer much more power than many of you are taking advantage of if you're still using an MS-DOS or PC DOS or *Windows* 3.0 or 3.1 operating system.

The DOS and *Windows* operating platforms primarily provide for single-application processing. *Windows* 3.1 approaches multitasking by allowing you to easily switch between launched applications but slows down —and in some cases even stops—the processing of one while another is on the screen and working. If a troublesome *Windows* application gives you a "General Protection Fault" error message, your PC will stop in its tracks. Both operating platforms can often result in a complete system crash or lock-up if one application runs into memory or device conflicts.

IBM's OS/2 2.1 lets you seize the true power of 32-bit 386 and 486 microprocessors for your applications that DOS and Windows can't provide.

IBM's OS/2 2.1 lets you seize the true power of 32-bit 386 and 486 microprocessors for your applications that DOS and *Windows* can't provide. It features an object-oriented Graphical User Interface (GUI), the WorkplaceShell Desktop, that permits seamless running of *Windows*, DOS and OS/2 applications simultaneous-



The Workplace Shell is a graphical user interface that brings a superior look and feel to IBM/compatible PCs. Shown here on the screen are opened system and productivity folders.

ly. You don't even need DOS or *Windows* installed on your PC.

Inside OS/2

OS/2's flat, or linear, memory model permanently shatters the 640K memory limit of DOS. This lets you give each application up to 48M of combined expanded or extended memory without breaking the memory into segments. The result is no "Out of Memory" error messages.

OS/2's flat, or linear, memory model permanently shatters the 640K memory limit of DOS.

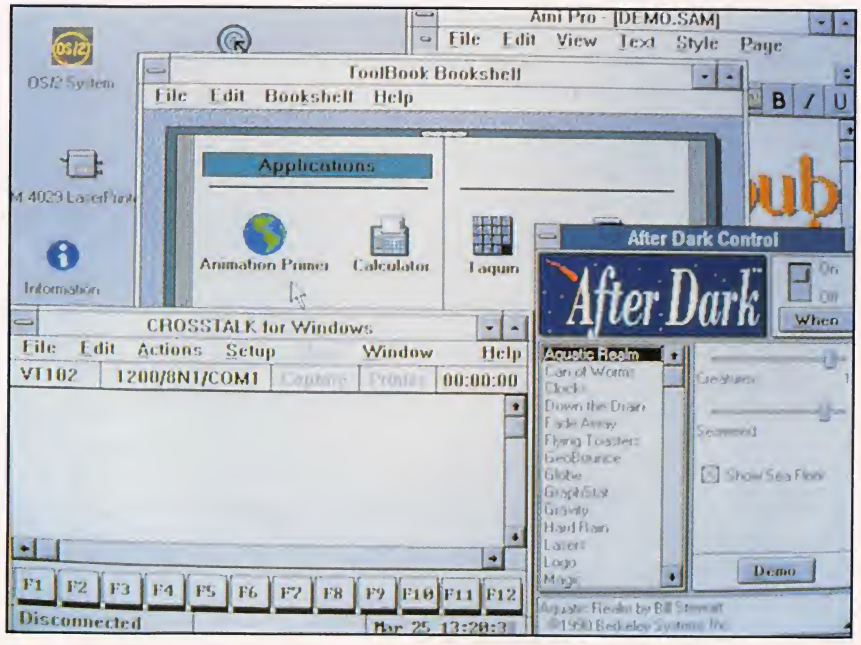
Perhaps OS/2's best feature is that it provides a powerful memory manager that enables the operating system to use all available RAM to set up as many as 240 Virtual DOS Machines (VDMs), each capable of running independent DOS and *Windows* sessions. This lets you safely run simultaneous DOS, *Windows* and OS/2 applications in a crash-proof environment such that if one application fails, it won't bring down your system and the other applications with it.

Currently, there are some restrictions on the types of applications you can run under OS/2's VDMs. Those that use VCPI DOS extenders won't run, although DPMI DOS extenders will. Virtually all *Windows* applications will run under OS/2, the only exception being applications that use *Windows* Virtual Device Drivers (VxDs) or the WIN32 Automatic Peripheral Interface (API) drivers used to run a 32-bit *Windows* program. However, there aren't many of these types of applications at present (most *Windows* programs are written in 16-bit format). Perhaps future versions of OS/2 will support these applications. For now, a Dual Boot feature lets you reset your PC to DOS to accommodate this software when needed.

Multithreading is another unique OS/2 feature. This lets applications work behind the scenes. Multithreading would occur when you wish to simultaneously execute internal functions of an application, such as printing, re-pagination and spell-checking on a word processor. It's especially useful with 32-bit communications packages, where concurrent functions help speed the data flow, letting your PC send data through one serial connection and receive through another connection and still permit another task to be completed. To use this facility for communications, plan on obtaining a true 32-bit OS/2 communications package, such as Hilgraeve's $199 *HyperAccess/5* for OS/2 (see "OS/2 2.1 and High-Speed Communications," March/April 1994 issue of *MicroComputer Journal*, for a review of this package).

Adding it Up

OS/2 2.1 is available in many forms for different installation needs. The $149 mail-order package delivers the full version of OS/2 2.1 that includes a working copy of DOS 5.0 and *Windows* 3.1, an efficient memory manager and support for many display

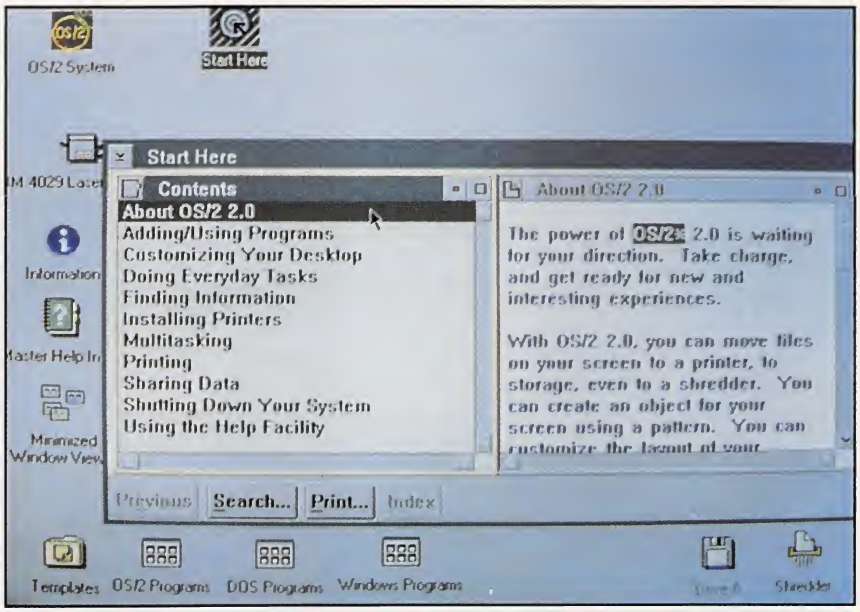


One of the many features of OS/2 2.1 is its seamless environment. DOS, Windows and OS/2 applications can run concurrently on a Workplace Shell desktop.

adapters, SCSI controllers, audio cards, Adobe and *TrueType* fonts and more than 260 Epson-compatible dot-matrix and Hewlett Packard ink-jet and laser printers and compatibles besides the OS/2 environment. If you already have DOS 5.0 installed on your desktop, an upgrade version is available for a mail-order price of $125. If both DOS 5.0 and *Windows* 3.1 are installed on your PC, for about $40, you can get *OS2FW* (*OS/2 for Windows*), which delivers all the OS/2 features and keeps your current and familiar *Windows* 3.1 setup.

All this new productivity doesn't come free simply with the installation of OS/2. You have to pay a price in terms of money that goes beyond the initial cost of the software and time spent installing and learning how to use the new operating system.

Before you purchase OS/2, inven-



OS/2 2.1 users can learn how to run the system in a simplified, easy to use manner, using the "Start Here" icon as a quick reference guide to this advanced operating system.

OS/2 History

IBM introduced OS/2 1.0 about two years after Intel debuted the 32-bit 386 microprocessor chip in 1985. It was designed as an alternative operating system and offered limited support for DOS and no support for *Windows* applications. It was primarily targeted for corporate PCs that usually involved networking and proprietary applications. In 1989, Microsoft, developer of the MS-DOS and *Windows* operating systems, and IBM announced a strategy that supposedly would limit DOS and *Windows* to low-end PCs, reserving OS/2 as the operating system for high-end microcomputer systems.

OS/2 1.3 with a Presentation Manager GUI front-end appeared in 1989 to take advantage of the new Intel 486 as well as the 386 microprocessors. It included *Adobe Type Manager* (*ATM*); a Dual Boot feature that allowed a user to start up his PC with DOS or OS/2; introduced a choice of the FAT or HPFS filing formats for the hard disk; running DOS and/or OS/2 applications concurrently and independently (true multitasking); the REstructured eXtended eXecutor (REXX), a powerful OS/2 procedures programming language; 16M of real memory address-ability, with access to virtual memory, if needed; actual drag-and-drop icon features; and extensive communications and networking capabilities. Even with all this, it still lacked support for *Windows* applications.

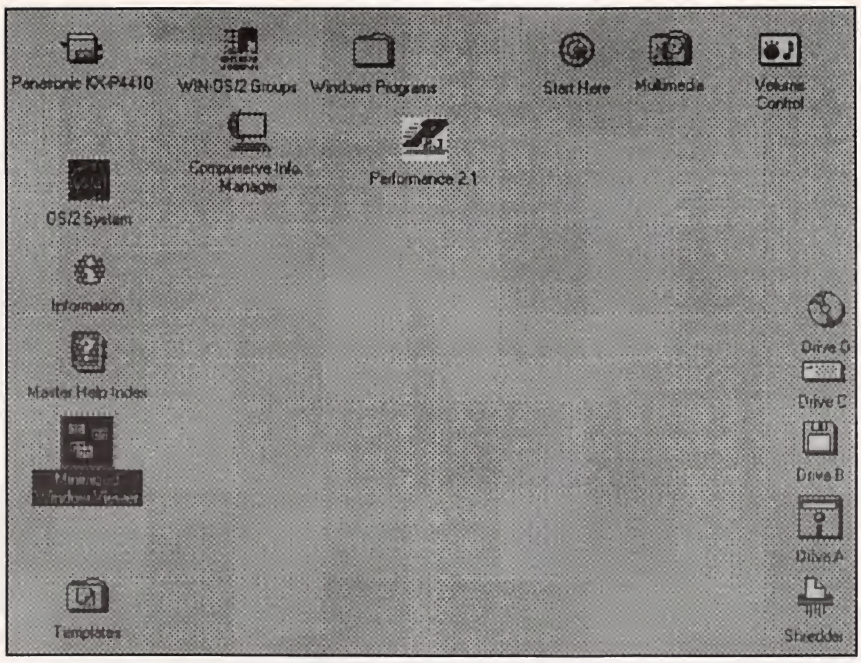
By 1990, Microsoft and IBM severed their partnership in creating a 32-bit-architecture operating system. IBM would take full responsibility for developing the OS/2 32-bit operating system, while Microsoft would develop *Windows NT* as a *Windows*-based 32-bit operating system.

In March of 1992, IBM introduced OS/2 2.0 as a 32-bit operating system for the PC that included the object-oriented drag-and-drop WorkplaceShell GUI front-end with full support for DOS and OS/2 applications and limited support for *Windows* 3.0 applications. There was virtually no support for *Windows* 3.1, which was released by Microsoft a month later, in April. Actually, Version 2.0 was a mixture of a 16-bit Presentation Manager and WorkplaceShell GUI module and a 32-bit operating and file-system module. Anything having to do with multimedia applications could be supported only with additional purchase of the Multimedia Presentation Manager for OS/2 add-on. OS/2 2.0 lacked the 32-bit graphics engine needed to work at the promised speed. During the fourth quarter of 1992, the release of a *OS/2 2.0 Service Pack* corrected that deficit.

By May of 1993, IBM had pulled it all together in its release of OS/2 2.1, providing an enhanced version of the 32-bit operating system with the WorkplaceShell GUI for Intel-based 386 and 486 PCs that offered full seamless support for DOS 5.0, *Windows* 3.1 and OS/2 applications; the 32-bit graphic engine; *Adobe* and *TrueType* fonts; built-in multimedia features; PCMCIA 2.0 credit-card-sized adapter card and an Advanced Power Management feature for longer battery life in mobile PCs. Version 2.1 also enhanced the faster and more-efficient HPFS filing format to the PC by letting a user choose to keep the normal DOS FAT filing format and/or using the HPFS filing format.

Since November 1993, IBM avoids paying royalties on Microsoft *Windows* by offering *OS/2 2.1 for Windows* (*OS2FW*) to the vast *Windows*-user base. *OS2FW* installs itself over an existing *Windows* setup and makes it a part of a new full-featured OS/2 operating system with all familiar *Windows* screens and setup intact. It uses the Microsoft *Windows* code already on a *Windows* PC.

OS/2 2.1 lets you finally take full advantage of the 32-bit processing architecture of the Intel-based 386, 486 or Pentium microprocessor to increase PC productivity by enabling you to simultaneously print a file, format a disk, render an image, download data from another PC, receive a fax, recalculate numbers on a spreadsheet and work on a document.



Screen capture of author's desktop under OS/2 2.1.

tory your PC hardware. You need hardware that enables you to enter the future. Your old IBM PC-, XT- or AT-compatible is useless for an OS/2 2.1 setup. Unless you're now operating DOS and/or *Windows* on an enhanced 486 PC, you'll have to add significantly to the cost of your OS/2 purchase. You must figure in the expense of upgrading or even replacing your current PC, depending on what applications you're planning to use.

IBM suggests that a basic OS/2 2.1 system include a 386SX PC with at least 4M of RAM, 100M hard drive and 14" VGA video monitor with 0.28-mm dot pitch. Such a setup is readily available for less than $700 from some mail-order houses, with some even pre-installing OS/2 2.1 for you. However, OS/2 is most-efficient and runs at its best with a minimum of 8M of RAM. If you plan on multitasking more than two major applications at a time, install upwards of 16M of RAM, and make sure that the motherboard in your PC can accommodate up to 32M of RAM. (Since recovery from last summer's fire at Sumitomo Chemical Co. in Japan, the company responsible for the production of more than 60% of the world's epoxy resin compound used to make integrated circuits, you can figure in $45 to $60 per megabyte of RAM upgrade.)

You should have at least 35M to 40M of hard-drive space available for full OS/2 2.1 installation. Once you're comfortable with OS/2, you'll be able to free up about 20M to 25M of space by deleting your old *Windows* and DOS directories (delete DOS *only* if you're installing *OS2FW*) and any memory managers you may now have on your PC. As a comparison of 32-bit operating systems, Microsoft's *Windows NT* reportedly requires 70M of hard-drive space for installation and at least 16M of RAM to operate.

OS/2 lets you gradually ease into the use of your new operating system by installing a Dual Boot feature that enables you to restart your PC with DOS if you find OS/2 taking too long to get used to. You can also opt to install a Boot Manager that lets you select the operating system you want your PC to use for start-up.

When upgrading your PC's operating system to OS/2 2.1, give consideration to the OS/2, DOS and *Windows* applications you plan to run. A word processor like *Describe OS/2* ($495) or Lotus *Ami Pro for OS/2* ($495) will consume 20M to 25M of disk space for just the program and some font files. Desktop-publishing software like Aldus *Pagemaker* ($895) and *Corel Ventura Publisher* ($795) will take up another 20M to 30M of disk space. An extensive draw/paint and illustration program like *CorelDRAW! OS/2* ($199) or *CorelDRAW!* 5 ($595) will consume 30M to 35M of space for its program and clipart files. A spreadsheet like Microsoft *Excel* ($495) or Lotus *1-2-3 for OS/2* ($495) requires 20M to 25M for the program, charts and clipart files. Lotus' *SmartSuite for OS/2* ($795) wants more than 70M and includes word-processing (*Ami Pro* 3.0), spreadsheet (*1-2-3*), presentation graphics (*Freelance*) and interoffice communications (*cc:Mail*). If you have the slightest inclination to use any of these applications, factor in the cost of a fast IDE drive with a capacity of, say, 345M, adding $300 or so or a 540M drive that adds around $500 or so to the cost of your OS/2 2.1 setup. If you think you might go beyond this, install a SCSI hard drive that can go into the gigabyte storage range for between $1,000 and $1,500.

Graphics card selection is an essential factor in the installation of OS/2.

Graphics card selection is an essential factor in the installation of OS/2. PC hardware offers you four levels of color resolution. Four-bit basic color VGA displays 16 colors at resolutions up to 640 X 480 pixels. Eight-bit color super VGA displays 256 colors at resolutions up to 800 X 600. Sixteen-bit HiColor displays 32,800 colors at up to 800 X 600. Finally, 24-bit TrueColor displays 16.7-million colors at up to 1,024 X 768 resolution. OS/2 2.1 offers a seamless 32-bit graphic engine with display drivers for all standard 16-color four-bit display adapters.

Also included in OS/2 2.1 are Super VGA (SVGA) drivers for the popular industry chipsets from ATI, Cirrus Logic, Headland, Trident, Tseng and Western Digital. Specifically, OS/2 supports ATI28800; Cirrus Logic CL-GD5422 and 5424; Headland Technologies HT209; IBM VGA256C; Trident Microsystems TVGA8900B and 8900C; Tseng Labs ET4000; and Western Digital WD-90C11, 90C30, 90C31 chipsets. If you have display adapters from other manufacturers, you must obtain OS/2 drivers from them to get SVGA support. Installation of these third-party drivers can be a bit tricky.

Learn to Use Your Computer's Full Potential.

New Career Course from CIE!

If you've been hesitating about upgrading your computer skills because you couldn't find the time or locate the right program to teach you everything you need to know to be successful in today's world of computers, you'll be happy to hear that CIE's new career course can provide you with the computer technology curriculum you seek in an independent study program you can afford to invest your time in.

CIE's COMPUTER OPERATION and PROGRAMMING course was designed and developed by CIE to provide a complete overall understanding of the unlimited potential today's computers offer, once you learn and discover their full capabilities, in today's high tech environment. CIE's new computer course quickly provides you with the electronics fundamentals essential to fully understand and master the computer's technological potentials for your personal and professional advancement. Upon mastering the fundamentals you will move into high level language programming such as BASIC and C-Language and then use that programming in order to relate the interfacing of electronic hardware circuitry to programming software. As a graduate of the Computer Operation and Programming course, you will be able to successfully understand, analyze, install, troubleshoot, program and maintain the various types of electronic equipment used in business, manufacturing, and service industries.

Since 1934, CIE has been the world leader in home study electronics by providing our 150,000-plus graduates with the curriculum and hands-on training they've needed to become successful in today's highly competitive and computer oriented society. As a CIE student you'll receive a first rate education from a faculty and staff with only one desire. Your future success!

We encourage you to look, but you won't find a more comprehensive computer course anywhere! And it's a course designed to fit around your lifestyle and commitments today, so you can be assured of professional successes and financial gains tomorrow.

Please, do yourself a favor and send the attached card or fill out and mail the coupon below for more information about CIE's Computer Operation and Programming course. Do It Today!

Computer not included with course

❒ YES! I want to get started. Send me my CIE school catalog including details about the Associate Degree program (for your convenience, CIE will have a representative contact you - there is no obligation).

Print Name _____

Address _____ Apt. _____

City _____ State _____ Zip _____

Age _____ Area Code/Phone No. _____

Check box for G.I. Bulletin on Educational Benefits ❒ Veteran ❒ Active Duty

CIE CLEVELAND INSTITUTE OF ELECTRONICS, INC.

1776 East 17th Street • Cleveland, Ohio 44114 • (216) 781-9400

ACCREDITED SCHOOL · NATIONAL HOME STUDY COUNCIL · NHSC

A school of thousands. A class of one. Since 1934.

AO37

Recently, IBM has added a disk in its OS/2 bundle to easily install support for the Sierra Semiconductor Hi-Color (S3) RAM DAC accelerator chipset display adapters. I'd definitely advise sticking with the fully supported manufacturers and chipsets. Keep in mind that most of the recent popular *Windows* graphics and multimedia applications now require a minimum of 256 colors at 640 X 480 resolution (SVGA).

If you want to work with images in SVGA under OS/2, use at least an ISA High Color accelerator card like the Diamond 1M Stealth 24 ($165), 2M Stealth Pro ($249) or STB 1M Powergraph X-24 ($165) with the (S3) accelerator chipset to produce up to 16.7-million colors and significantly speed up a screen's refresh rate. Upon installation of OS/2's S3 drivers provided with newer packages or directly from IBM, you'll be able to select the desired resolution required by your application.

OS/2's WorkplaceShell Desktop can put up a lot of information on your screen. If you plan to multitask applications, many windows will be simultaneously displayed on the Desktop, which you'll have to be able to read. They'd work minimally at the normal resolution of 16 colors at 640 X 480 and require a 15" monitor like the Philips 1520 Brilliance ($699) that supports a 72-Hz refresh rate and the Video Electronics Standards Association (VESA) standard to obtain flicker-free eye comfort. An added plus with this monitor is a built-in stereo amplifier with internal speakers, headphone jack and volume control for multimedia use. Some users may find the Philips 17" Brilliance or Viewsonic 7 ($1,299) monitor, offering a flicker free 76-Hz refresh rate, even easier on the eyes.

Built-In Support

Now let's take a closer look inside the OS/2 operating system package.

• **Multimedia Support.** OS/2 2.1 comes with IBM's Multimedia Presentation Manager/2 (MMPM/2) that provides extensive multimedia features as part of the basic operating system. It has been enhanced to play digital motion video in software at 30 frames per second, with no video hardware required. MMPM/2 provides system sounds on the Desktop (similar to *Windows* 3.1), an audio recording and editing applet and an easy-to-use applet for playing CD-ROMs.

MMPM/2 provides a full set of multimedia programming interfaces, enabling you to use OS/2 Ultimedia and *Windows* MPC applications. IBM and some multimedia vendors have developed the OS/2 Ultimedia Tools Series (UTS) logo to indicate hardware and software compliance with the OS/2 MMPM/2 setup. The UTS is an effort to establish standards that make it easier for end-users to utilize multimedia tools. They choose to support the operating system platforms that people are using—DOS, *Windows* and OS/2.

Minimum specifications for Ultimedia compliance include a 386SLC 20-MHz CPU with 4M of RAM, CD-ROM XA drive, 160M hard disk, SVGA display, CD-audio subsystem and microphone running under OS/2 2.1 with MMPM/2 with support for DOS and *Windows* 3.1 MPC applications. The *Windows* Multimedia PC Marketing Council (MPC) has established hardware and software standards for the *Windows* multimedia market: MPC1 or MPC2 (see "Tuning Up Your Computer," March/April *MicroComputer Journal* for specifics). If you plan to use multimedia, look for either the OS/2 Ultimedia Tools Series or MPC logo on hardware and software to confirm compliance with these standards.

MMPM/2 supports MIDI, .WAV and CD/XA industry-standard sound file formats and includes device drivers for MediaVision's Pro Audio Spectrum 16 ($195) and Pro Audio Studio 16 ($245) cards, Creative Lab's SoundBlaster family of cards ($99 to $250) and the IBM M-Audio card ($495). Factor in another $25 to $75 for a pair of small self-amplified external speakers to hook up to the sound card. Again, I can't stress enough that you should stay with the above vendors for easy installation of OS/2. Using third-party sound cards and drivers is an invitation to frustration.

Due to its ability to multitask and multithread applications, OS/2 is very sensitive to port (LPT1, LPT2, COM1, COM2, COM3 or COM4) and interrupt (IRQ) assignments in a PC's hardware configuration. When I was installing a SoundBlaster audio card that had a factory setting of IRQ7, it worked fine on my DOS and *Windows* operating system. After installing OS/2, though the sound was fine, I lost printing control because OS/2 uses and holds onto IRQ7 for all printing to LPT1. Basically, OS/2 doesn't want to share interrupts or ports between hardware peripherals. I had to use IRQ10 to get everything working smoothly. With the Pro Audio Studio 16 card, I had to select IRQ15.

Table 1.
IRQ Assignments on PCs

IRQ	Associated Device
0	System Timer
1	Keyboard
2	Secondary Interrupt Controller
3	COM2 (Serial Communications Port 2)
4	COM1 (Serial Communications Port 1)
5	LPT2 (Parallel Port 2)
6	Floppy Drive
7	LPT1 (Parallel Port 1)
8	Realtime Clock
9	Open
10	Open
11	Open
12	Auxiliary Port (Mouse)
13	Math Coprocessor
14	Hard Drive
15	Open

As you can see from the foregoing, it's important to shop for peripherals that offer as many IRQ choices as possible. On the horizon is a plug-and-play technology that will be on the PC motherboard and will configure peripherals to non-conflicting values when you connect them to your PC. For now, though, Table 1 guides you to the open, or available, interrupts on the ISA machine.

Keep in mind that the IRQ9 pin in the IBM-AT (ISA bus) is identical with the IRQ2 pin on the original IBM-PC. If you have an earlier, eight-bit adapter with documentation that uses IRQ2, be aware that this will actually be interpreted as IRQ9 when the card is plugged into the 16-bit ISA bus.

• **CD-ROM Support.** OS/2 2.1 takes full advantage of CD-ROM technology and is offered on CD-ROM ($125 full, $90 upgrade, $35 *OS2FW*) for easy and fast 15-minute installation. Without the CD-ROM, you're faced with 25 to 27 floppy disks and more than an hour of swapping during in-

stallation. While adding a CD-ROM drive can be an expensive option (prices are dropping rapidly at this time), it's a step you should seriously consider to bring your PC up to date. Many vendors are beginning to market their software on the less-expensive CD-ROM medium for faster and easier installation. In future, software distribution is likely to be exclusively on CD-ROM.

OS/2 directly supports SCSI CD-ROM drives ($295 to $695) from Hitachi (CDR1650S, 1750S, 3650 and 3750); IBM's CD-ROM I and II; Panasonic's CR-501, LK-MC501S, MC501B, MC521; Pioneer's DRM-600 and 604X; Sony's CDU-541, 561, 6111, 6211 and 7211; Texel's DM- 3021, 3042, 5021 and 5024; and Toshiba's XM-3201, 3301 and 3401 drives. The NEC Intersect and Multispin CDR series is supported, but these drives usually come with a Trantor SCSI host adapter that will require you to get the OS/2 device driver from Trantor Systems (tel.: 800 959-7274). CD-ROM drives like the Toshiba TXM 3401 ($495 to $595) series, are controlled by SCSI-2 protocol and offer the best flexibility in allowing you to chain up to seven SCSI devices (tape drives, hard drives, scanners, CD-ROM, etc.) from one controller card like the Adaptec 1542 ($200). The Toshiba TXM 3401 double-speed series CD-ROM drives exceed both the Ultimedia and MPC level 2 compliance by offering a 330K/s transfer rate with a 200-ms average access time, a 256K on-board buffer and CD-ROM XA, multisession and Kodak Photo CD compatibility.

When shopping for an SCSI adapter ($75 to $250), look for the more-compatible SCSI-2 standard that eliminates hardware problems and boosts performance. Additionally, use of the Advanced SCSI Programming Interface (ASPI) Manager developed by Adaptec has created universal industry standards permitting easy hookup of any SCSI device to your PC. OS/2 effortlessly handles this part of the installation by supporting SCSI and ASPI.

OS/2 2.1 directly supports SCSI adapters from Adaptec (AHA 1510, 1520, 154x, 164x and 174x; DPT (PM 2011 and 2012); Future Domain (TMC-845, 850, 860, 875, 885, 1650, 1660, 1670, 1680, FD7000EX, MCS 600 and 700); and, of course, IBM. Again, third-party vendors of SCSI controller cards and CD-ROM drives controlled by proprietary cards should most definitely be avoided when installing OS/2. Pleasantly, though, I found the MediaVision Pro Audio Studio 16 sound card, which has an on-board SCSI-2 adapter, very easy to install and run a Toshiba TXM3401 internal CD-ROM drive, even though I had to install a third-party OS/2 driver. All I had to do was add the OS/2 driver, provided by MediaVision, to the OS/2 CONFIG.SYS file, following the simple instructions included.

• **More Device Support.** If you have SCSI Removable Storage Media that use SCSI controllers, OS/2 directly supports the Bernoulli 44M and 89M and SyQuest drives. Quantum Hard Cards can also be used, with a little help from Quantum. IBM, Irwin, Colorado Jumbo and Mountain tape drives are better supported through use of OS/2 backup software, such as MSR Development's *BackMaster for OS/2* ($79) or Sytron's *Systos Plus for OS/2* ($199).

By the time you read this, IBM will probably have released an *OS/2 2.1 Service Pak*, which is aimed at making the operating system even more stable and more compatible with a large number of third-party hardware and software products. This means many more drivers for formerly unsupported display adapters and less-common CD-ROM drives, as well as a correction of about 520 known glitches. In addition, according to beta testers, *OS/2 2.1 Service Pak* seems to require 1M to 2M less RAM. It's to be available directly from IBM by calling 800-342-6672.

You'll have an easier job of installing OS/2 if you first decide upon and gather together every piece of hardware you want for your OS/2 system before installation.

Installing OS/2

I'll preface the following with a word of advice. You'll have an easier job of installing OS/2 if you first decide upon and gather together every piece of hardware you want for your OS/2 system before installation. Adding hardware to an existing OS/2 system can be frustrating and may even require you to re-install the operating system. (There's no better reason than this for getting the CD-ROM version.) Also, if you're using data-compression software like *Stacker* or DoubleSpace, you must de-compress your hard drive before installing OS/2. Stac Electronics offers a *Stacker for OS/2* ($199), but you can use this later if you want data compression. In any case, make sure you completely back up your existing hard drive to protect what you have!

If you have DOS already installed, OS/2 automatically sets up a Dual Boot feature. However, if you want to have the Boot Manager feature, you must have enough space to re-partition your hard drive for each operating system you want to start up in when you turn on your PC. You'll have the choice of reformatting your hard drive with the File Allocation Table (FAT) and/or High Performance File System (HPFS) filing format.

DOS organizes files using the FAT filing format and doesn't recognize the HPFS available with OS/2. HPFS is OS/2's way of making file management flexible. It's benefits are numerous and include: longer filenames of up to 254 characters; resistance to disk fragmentation for higher performance (five to 10 times faster than FAT); and easy reading and writing of traditional DOS FAT files. When it writes to a floppy, OS/2 automatically uses the FAT format. Since it takes up approximately 500K of system RAM, OS/2 requires a minimum of 6M of RAM and 60M or more of clear hard-drive space. If you're using a large hard drive, HPFS is a better choice for managing it. In either case, with OS/2, both HPFS and FAT read ahead (for sequential I/O); "lazy write" to disk; and accept threshold parameters. Therefore, even if you don't have the 6M of RAM required for HPFS, OS/2 will still run FAT files faster. You can add the HPFS option to your system later through the Selective Install utility program in the System Setup object.

Starting installation is as simple as placing the Installation floppy in drive A: and turning on your PC. The

Starting installation is as simple as placing the Installation floppy in drive A: and turning on your PC.

floppy boots up your PC and prepares it for OS/2. With the CD-ROM version, place the CD-ROM in your drive and the floppy in drive A: before start-up. A series of questions will appear on-screen concerning your desires to re-format your hard drive partitions with FAT or HPFS. When you finish responding to these, you'll be asked to reboot your PC.

On re-booting, the first screen offers to teach you how to use a mouse. Following this, three choices are displayed: Install Preselected Features, Install All Features or Select Features and Install. After each choice is an indication of the hard-drive space needed for the operation. Throughout installation, a Disk Space window keeps a running total of available space on your hard drive versus needed space for the selected feature to be installed.

Next, installation detects the types of devices connected to your PC and displays this information in a System Configuration window. You can change any of the system, locale or peripheral devices from an on-line list to correct any errors and additions. You can call up this window at a later time to add new peripherals through the Selective Install folder in the OS/2 System object.

If you choose "Select Features and Install," you're taken through a series of windows to select the parts of OS/2 you'd like to install. If you're using floppy-disk installation, you'll be prompted to insert the 20 to 27 diskettes at the appropriate times. If you're installing *OS/2 for Windows*, you must have your original *Windows* 3.1 installation disks standing by. Using the CD-ROM loads the installation continually without prompting for floppies, unless you're installing *OS2FW*. Once all the features are installed you'll be able to migrate your DOS and *Windows* programs to the OS/2 Desktop. The migration procedure is usually repeated through the System Setup folder, in the OS/2 System object, whenever you want to install a new DOS or *Windows* program onto the Desktop of the WorkplaceShell.

Once all is in place, you're placed into the OS/2 Tutorial. The Tutorial and an Information folder are always available on your Desktop to help you with any questions you may have concerning using and customizing your WorkplaceShell Desktop. You'll find that all OS/2 and *Windows* programs have context-sensitive help readily available.

When you finish the tutorial, you'll notice an arrangement of objects on your OS/2 Desktop. These objects represent items (applications or files attached to applications) in your Desktop environment and are displayed as icons.

To install the MMPM/2 module, you begin to actively use the OS/2 operating system first-hand. The whole OS/2 and MMPM/2 installation process should take a little more than an hour if installation is from floppies and considerably less time if you use the CD-ROM, provided you're using hardware that's directly supported by OS/2.

To leave OS/2, *don't* just turn off your PC when you're through with an application or see the C:> prompt, as you do with a DOS or *Windows* PC. Access the Shutdown command on the Desktop Menu through a right-button mouse click anywhere on the OS/2 Desktop. This will save all your work and the Desktop configuration. At the next startup, everything goes back to where you were. Turning off power without "Shutdown" or in the middle of any OS/2 session may damage the PC's initialization files and corrupt the Desktop, even if all of the files are saved.

Needless to say, it's essential that the hardware and the operating system be in sync with each other. Use of memory management and swapping, file management, print spooling and disk caches are all factors to operate OS/2 efficiently. Clear & Simple's *Performance 2.1 Plus* disk helps you optimize your installation of OS/2 to produce maximum performance from your PC by running system diagnostics. Once you run the diagnostics, specific tips are suggested and performed to configure and fine-tune the OS/2 setup on your PC for optimum performance. This $9.95 disk contains many other helpful util-

ity programs for effectively using OS/2 (one creates an OS/2-bootable floppy), an on-line book full of OS/2 tuning tips and information and more than 3,000 public-domain OS/2 icons to attach to your Desktop objects.

OS/2 places on your Desktop many object-oriented applets, complete with context-sensitive on-line help, that offer a range of useful applications that demonstrate the 32-bit environment in graphics, communications, system and time management. A Productivity folder in the OS/2 System object offers up programs for a spreadsheet and chart-making; database; terminal emulation; font, icon, system and file editing and viewing; daily planning; file searching; and a few games. Currently purchased OS/2 packages have added a Fax/PM applet to the Productivity folder for simple 32-bit faxing. The *Windows* module (WIN-OS/2) also includes the familiar *Windows* Accessories Group.

IBM includes a readable manual and a step-by-step installation booklet that, when added to all the on-line help files, give you two great sources for learning how to use and customize your OS/2 Desktop. Beyond this, there's readily available support directly from IBM by calling 800-992-4777; through CompuServe Information Service (CIS); and from hardware and software vendor's bulletin board systems (BBS) for assistance with installation, application and hardware problems. IBM maintains extensive OS/2 on-line support through forums and software libraries on CIS (GO OS2SUP). For information concerning registration and access to IBM's own OS/2 BBS, call 800-547-1283. For CIS membership information, call 800-848-8199.

Since OS/2 2.1 appeared, many books have been published to help beginners and experts alike. There's even *OS/2 For Dummies* ($19.95) by Andy Rathbone from IDG Books (tel.: 800-762-2974). If all these should fail to help, feel free to contact me on CIS: #71241,3031, and I'll try to give you some suggestions.

Native Applications

Once you install OS/2 2.1 on your PC, it's time to look at some of the 32-bit software available for running under this operating system. The fol-

Hardware Sources

SCSI Controllers

AHA-1540C Series
Adaptec Corp.
691 S. Milpitas Blvd.
Milpitas, CA 95035
Tel.: 408-945-8600

CIRCLE NO. 134 ON FREE INFORMATION CARD

TMC-800 & TMC-1600 Series
Future Domain Corp.
2801 McGaw Ave.
Irvine, CA 253-0400

CIRCLE NO. 135 ON FREE INFORMATION CARD

Sound Cards

Sound Blaster Pro
Creative Labs, Inc.
1901 McCarthy Blvd., Ste. 214
Milipitas, CA 95035
Tel.: 408-428-6600

CIRCLE NO. 136 ON FREE INFORMATION CARD

Pro Audio Spectrum 16; Pro Audio Studio 16
Media Vision, Inc.
47330 Baysville Pkwy.
Fremont, CA 94538
Tel.: 510-770-8600

CIRCLE NO. 137 ON FREE INFORMATION CARD

Display Adapters

Stealth 24 /Pro
Diamond Computer System
1130 E Arques Ave.
Sunnyvale, CA 94086
Tel.: 408-736-2000

CIRCLE NO. 138 ON FREE INFORMATION CARD

Powergraph X-24, VL-24; Pegasus VLB
STB Systems, Inc.
1651 N. Glenville
PO Box 850957
Richardson, TX 75085-0957
Tel.: 214-234-8750

CIRCLE NO. 139 ON FREE INFORMATION CARD

MX7345A; MX540S Hard Drives
Maxtor Corp.
2190 Miller Dr.
Longmont, CO 80501
Tel.: 303-651-6000

CIRCLE NO. 140 ON FREE INFORMATION CARD

CD-ROM Drives

NEC Technologies
1414 Massachusetts Ave.
Boxborough, MA 01719
Tel.: 508-264-8000

CIRCLE NO. 141 ON FREE INFORMATION CARD

Sony Corp. of America
655 River Oaks Pkwy.
San Jose, CA 95134
Tel.: 714-826-6410

CIRCLE NO. 142 ON FREE INFORMATION CARD

Toshiba America, Inc.
Disk Products Div.
9740 Irvine Blvd.
Box 19724
Irvine, CA 92713-9724
Tel.: 714-583-3000

CIRCLE NO. 143 ON FREE INFORMATION CARD

Video Monitors

Brilliance Series
Philips Consumer Electronics Corp.
Snapp Ferry Rd.
PO Box 1210
Greenville, TN 37744-1210
Tel.: 615-636-5871

CIRCLE NO. 144 ON FREE INFORMATION CARD

Viewsonic 5E, 17
Viewsonic, Inc.
20480 Business Way
Walnut, CA 91789
Tel.: 909-869-7976

CIRCLE NO. 145 ON FREE INFORMATION CARD

Fax/Modems

Hayes Microcomputer Products
6610 Bay Cir.
Norcross, GA 30071
Tel.: 404-840-9200

CIRCLE NO. 146 ON FREE INFORMATION CARD

Practical Peripherals
375 Conejo Ridge
Thousand Oaks, CA 91361
Tel.: 805-497-4774

CIRCLE NO. 147 ON FREE INFORMATION CARD

Software

IconAuthor
AimTech Corp.
20 Trafalgar Sq.
Nashua, NH 03063-1973
Tel.: 603-883-0220

CIRCLE NO. 148 ON FREE INFORMATION CARD

Pacemaker
Aldus Corp.
411 First Ave. S.
Seattle, WA 98104-2871
Tel.: 206-622-5500

CIRCLE NO. 149 ON FREE INFORMATION CARD

Performance 2.1 Plus
Clear & Simple, Inc.
PO Box 130
W. Simsbury, CT 06092
Tel.: 203-658-1204

CIRCLE NO. 150 ON FREE INFORMATION CARD

CorelDRAW! OS/2 & 5; Corel *Ventura Publisher*
Corel Corp.
1600 Carling Ave.
Ottawa, Ontario, Canada K1Z 8R7
Tel.: 613-723-8200

CIRCLE NO. 151 ON FREE INFORMATION CARD

lowing is a very abbreviated list of what's available.

If you're a member of CompuServe, Creative Systems Programming's *Golden CommPass* ($99) 32-bit native OS/2 navigation software lets you plan your communications tasks before you log onto CIS so that you spend less time sending, retrieving and paying for it. It enables you to run other applications in the foreground while downloading in the background, send mail while reading messages, open multiple windows and work with multiple files. *CommPass* includes drag-and-drop, message aging and archiving, phone and address book, on-line time tracking, context-sensitive help and support for any Hayes-compatible modem.

If you use your PC for faxing,you need a true 32-bit OS/2 fax program. like Microformatic's *Fax/PM* ($149) or Sofnet's *FaxWorks for OS/2* ($149). OS/2's multitasking capabilities permit you to send, receive and print in the background mode while you continue working with other applications in the foreground. Native DOS- and *Windows*-based fax programs may have problems in OS/2 due to its multitasking and multithreading characteristics causing COM-port conflicts when you try to run them in the background.

Fax/PM is an object-oriented fax product that lets you send faxes by selecting the *Fax/PM* driver as your printer in any application. You can send faxes right from the OS/2 Desktop by simply dragging and dropping a data object to the fax object.

Golden CommPass
Creative Systems Programming Corp.
PO Box 961
Mount Laurel, NJ 08054-0961
Tel.: 609-234-1500

CIRCLE NO. 152 ON FREE INFORMATION CARD

DeScribe for OS/2
DeScribe, Inc.
4234 N. Freeway Blvd., Ste. 500
Sacramento, CA 95834
Tel.: 800-448-1586

CIRCLE NO. 153 ON FREE INFORMATION CARD

HyperAccess/5 for OS/2
Hilgraeve, Inc.
111 Conant Ave.
PO Box 941
Monroe, MI 48161
Tel.: 313-243-0576

CIRCLE NO. 154 ON FREE INFORMATION CARD

OS/2 2.1; OS/2 2.1 for *Windows*; *Ultimedia Tools Series*
IBM Fulfillment Headquarters
PO Box 525
Dearborn, MI 48121-0525
Tel.: 800-342-6672

CIRCLE NO. 155 ON FREE INFORMATION CARD

Ami Pro; Lotus *1-2-3*; Lotus *SmartSuite*
Lotus Development Corp.
55 Cambridge Pkwy.
Cambridge, MA 02142
Tel.: 617-577-8500

CIRCLE NO. 156 ON FREE INFORMATION CARD

Fax/PM
Microformatic Corp.
610 Niederwefer Rd.,
PO Box 722
S. Windsor, CT 06074
Tel.: 203-644-1708

CIRCLE NO. 157 ON FREE INFORMATION CARD

Excel; MS DOS 5.0, 6.0; *Windows* 3.1; *Windows NT*
Microsoft Corp.
One Microsoft Way
Redmond, WA 98052
Tel.: 800-426-9400 or 206-936-8661

CIRCLE NO. 158 ON FREE INFORMATION CARD

BackMaster for OS/2
MSR Development
PO Box 632070
Nacogdoches, TX 75963
Tel.: 409-564-1862

CIRCLE NO. 159 ON FREE INFORMATION CARD

Multimedia PC Marketing Council
1730 M St. N.W., Ste. 707
Washington, DC 20036
Tel.: 202-331-0494

CIRCLE NO. 160 ON FREE INFORMATION CARD

FaxWorks for OS/2
SofNet, Inc.
1110 Northchase Pkwy., Ste. 150
Marietta, GA 30067
Tel.: 800 FAX-WORK

CIRCLE NO. 161 ON FREE INFORMATION CARD

Stacker for OS/2
Stac Electronics, Inc.
5993 Avenida Encinas
Carlsbad, CA 92008
Tel.: 619-431-7474

CIRCLE NO. 162 ON FREE INFORMATION CARD

Sytos Plus for OS/2
Sytron Corp.
134 Flanders Rd.
PO Box 5025
Westboro, MA 01581-5025
Tel.: 508-898-0100

CIRCLE NO. 163 ON FREE INFORMATION CARD

Video Electronics Standards Association (VESA)
2150 N. First St., Ste. 440
San Jose, CA 95131-2020
Tel.: 408-435-0333

CIRCLE NO. 164 ON FREE INFORMATION CARD

There's optional automatic displaying and/or printing of all received faxes, detailed logging and phonebook information, Workplace FAXIN and FAXOUT folders and automatic cover sheets and fax scheduling. Class 1 and Class 2 fax/modems are supported.

FaxWorks for OS/2 lets any OS/2, *Windows* or DOS application send faxes simply by using the print command. You can send faxes in the background from *Windows* or DOS when you're running under OS/2. This package supports most current fax modems, including Class 1, Class 2, Intel, GammaLink and Brooktrout. The program supports *Adobe Type Manager* and *TrueType* fonts and features image editing, an automatic-print feature to direct incoming faxes to your printer, unlimited phone books, customized cover sheets, annotating tools, unattended fax broadcasting and an optical character recognition (OCR) capability.

If you want to go beyond the basic multimedia features and get into serious multimedia development and experimentation, OS/2's MMPM/2 offers the capacity to proceed boldly into this new computer platform of the 1990s. Multimedia authoring software pulls together live video (.AVI and .DVI files), sound (.WAV, .MID and .VOC files), computer graphics and animation and text to create a multimedia presentation in much the same way desktop-publishing pulls together text and computer graphics to create camera-ready pre-press material. The hardware required to do this will significantly add to the cost to your OS/2 upgrade. Multimedia hardware and authoring software for OS/2 should be IBM Ultimedia-compliant.

Your OS/2 multimedia authoring platform should ideally contain a fast 486 or Pentium PC with 32M of RAM ($4,000), a 500M hard drive ($500), VGA-to-NTSC video card ($995), 17" multiscan video monitor ($1,500), audio capture/playback card ($495), full-motion video card ($1,500) and video image-capture card ($595). A keyboard, mouse or trackball, tablet and touch screen can serve as an input device. External hardware should include a flatbed scanner ($800), video-disc player and/or VCR ($500), NTSC video monitor ($250), a camcorder ($1,000), a CD-ROM player ($700), speakers, a MIDI controller ($250), an audio cassette recorder/player and a microphone.

IBM offers three programs that, when combined, greatly enhance the OS/2 MMPM/2 module:

- ***Ultimedia Perfect Image/2*** ($175) enhances an installed color scanner or video-capture adapter. You can select irregular shapes; re-size, flip and rotate the image before pasting; and drag and drop images to and from word-processing documents, multimedia presentations, email, spreadsheets and databases.
- ***Ultimedia WorkPlace/2*** ($345) is a powerful tool that lets you organize and manage your multimedia (video, image and audio) files and objects. Each multimedia file is represented as a "thumbnail," with user-defined text to aid in file searches. This program can integrate with relational databases (*dBASE IV*, *OS/2 Database Manager*, *Oracle* and *DB2/2*).
- ***Ultimedia Builder/2*** ($345) lets you create multimedia presentations that use images, audio, video, animation

and special effects through a film-strip-like storyboard work area. Finished presentations can be played back as a run-time file on another OS/2-equipped PC or annotate in email, spreadsheets and word-processing documents.

Each of the foregoing programs arrives on a CD-ROM that includes step-by-step interactive practice sessions and extensive on-line help.

Besides the IBM *Ultimedia Tools Series* products, there aren't as yet many 32-bit OS/2 programs available to help you along with experimenting and creating your multimedia presentations with this $10,0000-plus system. As OS/2 becomes more widely used, however, more authoring software should become available.

AimTech Corp. offers *IconAuthor* 5.1 for OS/2 ($4,999) as intuitive 32-bit authoring software that uses a flowchart of icon tools to speed development of interactive presentations that require little programming or scripting skills. This Package includes six run-time modules (an additional $50 each) and a four-day training course. Presentations are developed by creating structures and then adding content to the structures with icons that represent functions or tasks. ASCII text files; .BMP, .DIB, .PCX, .PICT, .RLE, .TIFF, .TGA and .WMF graphics files with up to 24-bit color; irregularly-shaped graphics objects; .WAV, .MID and CD audio files; animation and full-motion video files can be included as content using icon dialog boxes, each with its own editor. *IconAnimate*, a full animation scripter and a full graphics module with WYSIWYG editors are included. Presentations can be run, tested and edited in real-time.

New features include a new Smart Object Editor; enhanced *Windows* OLE, DDE and DLL support; a new graphical debugger; extensive digital video support for IBM-Intel's DVI (Digital Video Interactive) and Indeo, Microsoft's *Video for Windows* and Fluent's *Fluency; IAScope* that allows visual tracing of problems; and ASCII and .RTF file support and *Windows for Pen Computing*.

Most of the prices mentioned here are suggested retail and are usually discounted—often heavily—at local discount computer supply stores and through mail-order houses.

I was pleasantly surprised at how easy and fast OS/2 installed on my system.

User Comments

I was pleasantly surprised at how easy and fast OS/2 installed on my system. Since OS/2 2.1 was released, I've been running it on a 486DX33 with 8M of RAM, 345M hard drive, Philips Brilliance 1520 video monitor attached to a Diamond Stealth 24 display adapter, Toshiba TXM 3401 external CD-ROM drive through an Adaptec AHA 1542 SCSI adapter, SoundBlaster Pro audio card, Practical Peripherals 14,400-baud internal fax/modem and Microsoft Mouse. My printer is a Panasonic KX-P4410 laser model. The only thing I'll add soon is more RAM to really take advantage of major application multitasking.

As a computer writer/consultant, I'm constantly trying out or installing new software and hardware products. New DOS, *Windows* and OS/2 application software install onto the OS/2 Desktop, using the same commands as I did with DOS and *Windows* with great ease. You open up a DOS or *Windows* (WIN-OS/2) window and install the new DOS or *Windows* application as you would on a normal DOS or *Windows* PC. Then you migrate it onto the OS/2 Desktop. With OS/2 applications, you double-click on the drive icon and then on the application's install program, and the application installs itself onto the Desktop.

Once you've set up OS/2, installing new hardware can be a bit tricky.

Once you've set up OS/2, installing new hardware can be a bit tricky. I wouldn't recommend it for the non-technical user. There have been times when I've had to re-install OS/2 or parts of it. I was pleased to find that, in most cases, the OS/2 Desktop usually came back the way I left it before re-installation had to be done. OS/2 also seems to be a "smart" operating system in that if something does go wrong and you have to leave an application, upon shut-down and then starting up again, it resolves the conflict or problem and puts you back on-track.

Clients for whom I've installed OS/2 have taken advantage of the multitasking and multithreading capabilities to increase their productivity. Those who have taken the time to learn the operating system have found the object-oriented drag-and-drop and powerful customizing features very useful and easy to learn. What seem to be their favorite features are the speed at which DOS programs run and the stability of OS/2. Another favorite is the ability of OS/2 to recover from any crashes or near-crashes, making re-booting a rare event.

If you're looking for your PC to do more for you and make use of its true power, OS/2 is certainly a well-tested and proven operating system to install on your 386 or 486 PC. If you use *Windows*, stepping up to OS/2 shouldn't be very difficult or expensive using *OS/2 2.1 for Windows*. Your *Windows* setups will sit on a much more-powerful, stable and productive operating platform. DOS users will make their lives, and fingers, more relaxed using the object-oriented drag-and-drop command structure instead of DOS's character-oriented commands.

In the space that occupies your DOS, Windows, memory manager, print spooler, disk cache and utility software, you can put OS/2 2.1 that will do it all—and add multitasking and multithreading to your 386 or 486 PC, to boot.

In the space that occupies your DOS, *Windows*, memory manager, print spooler, disk cache and utility software, you can put OS/2 2.1 that will do it all—and add multitasking and multithreading to your 386 or 486 PC, to boot. For your investment in OS/2, you'll also turn your PC into as many virtual DOS machines as your applications require. OS/2 2.1 welcomes you to the world of true multitasking and multithreading and the future of object-oriented desktop microcomputing. ■

By Jan Axelson

How to Use a PC's Parallel Port for Monitoring and Control Purposes

Part 2

A cookbook of parallel-port applications

You can do a lot more with your computer's parallel port besides sending data to a printer. For this article, I've put together a variety of circuits that interface to a PC via its parallel, or printer, port. One circuit expands the port by increasing the number of bits you can control. Others show how to use the parallel port to turn on and off ac-powered devices, control a matrix of switches, set the gain of an amplifier and vary the speed and direction of stepper and dc motors.

There are many ways to achieve all of the above. In developing the ideas presented here, I looked for circuits that are as easy as possible to put together and program. Some use specialized components, but all are readily available from the sources listed in the Sources box at the end of the article.

Although the focus here is on interfacing to a PC's standard parallel port, you can also use the basic ideas to interface to any type of digital I/O port, such as those found on an I/O expansion card or microcontroller.

The Basics

In this installment, I build on the parallel-port information I gave in the May/June issue in Part 1 of this series. I assume you're familiar with the parallel port's 17 bits and how to read to and write from their registers.

Short program listings demonstrate the operation of the circuits. I wrote the programs in *QuickBASIC*, and you can also run them with the QBASIC interpreter included with recent versions of MS-DOS. I tried to include enough comments so that you can adapt the programs to your favorite programming language, whatever it may be.

In the text that follows, I refer to the bits on the parallel port as follows: the data port consists of output bits D0 through D7, and the control port consists of bidriectional bits C0 through C3, which I use only as outputs in the examples.

The schematic diagrams include all components except for decoupling capacitors (0.1-µF at each IC is recommended) and line terminations on the parallel-port cable, which you can add as described in Part 1. Also not shown are power-supply and ground pins for digital ICs that have standard pinouts.

Output Expansion

The basic parallel port has 12 output bits, identified as D0 through D7 and C0 through C3. If you want to control more than these, the circuit shown in Fig. 1 enables you to control up to 56 TTL-compatible outputs, one byte at a time.

Chips *U1* and *U4* buffer D0 through D7 and C0 through C3 from the parallel port. Four bits on *U4* are unused. Chip *U5*, a 74LS138 three-to-eight-line decoder selects the byte to control. When *U5* is enabled by tying G1 high and G2A and G2B low, one and only one Y output of the chip is low. Inputs A, B and C determine which output this is. For example, when CBA = 000, Y0 is low; when CBA = 001, Y1 is low; and so on up, with each value at CBA corresponding to a low Y output. Bits C0, C1 and C2 determine the values at A, B, and C.

74LS374 octal flip-flop *U2* latches D0 through D7 to its outputs. When Output Control pin 1 is low, a rising edge at Clock pin 11 causes the eight D inputs to be latched to the Q outputs. A logic low at C3 enables *U2*'s outputs, while a logic high brings them to a high-impedance state. To permanently enable the outputs, tie pin 1 of *U2* low and leave C3 unused.

Chip *U3* is a second octal flip-flop, wired like *U2* but with a different clock input. You can have up to seven 74LS374s, each controlled by a different output of *U5* (Y0 through Y6). Selecting Y7 causes the clock inputs of all of the 74LS374s to be high.

To write a byte, do the following: Write the data to D0 through D7. Write the address of the desired '374 to C0, C1 and C2 to bring its clock input low. Select Y7 to bring the selected clock input high again and latch the data to the outputs. Although you can write just one byte at a time, the values you previously wrote to other 74LS374s will remain until you reselect them and change the data.

Remember that the parallel port inverts C0, C1 and C3 internally. Therefore, you have to write the inverse of the desired logic state to these bits to the parallel port's control register. If

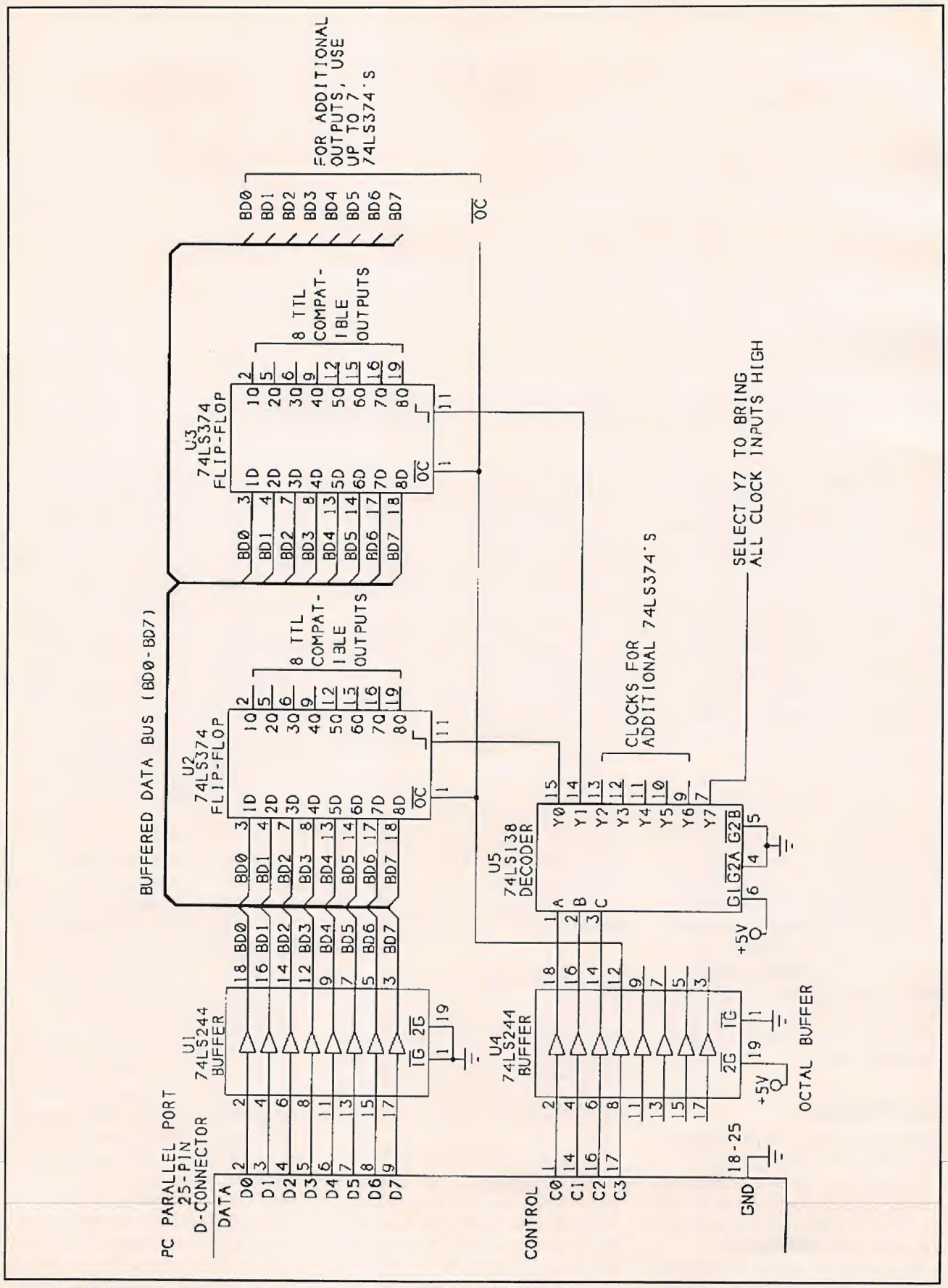


Fig. 1. With this circuit, you can control up to 56 outputs from your PC's parallel port.

Listing 1. Test Program For Fig.1 Circuit

```
'Output expansion of parallel port

DataPort = &H3BC                                        'set to match address of your parallel port
ControlPort = DataPort + 2
ControlMask = &HB                                       'reinverts C0,C1,C3

OUT ControlPort, &HF XOR ControlMask                    'ensure Y0-Y6 are high
OUT ControlPort, 7 XOR ControlMask                      'bring C3 low to enable outputs

DO
    INPUT "Select a latch to write to (0-6): ", LatchSelect
    INPUT "Data to write (0-255)? : ", DataByte
    OUT DataPort, DataByte                              'write requested data to D0-D7
    OUT ControlPort, LatchSelect XOR ControlMask 'bring selected Y output low
    OUT ControlPort, 7 XOR ControlMask                  'bring selected Y high to latch data
LOOP
END
```

you prefer, you can eliminate the need for this by adding inverters at pins 18, 16, and 12 of *U4*.

Listing 1 demonstrates the circuit's operation by prompting you to select a latch and then writing the data you request to that latch.

Controlling AC Power

You can use the parallel port's outputs to control ac-powered devices. Figure 2 shows how a solid-state relay switches power to an ac load. The relay provides a simple, safe way to switch power to devices that use high voltages or currents. A logic voltage at the relay's control inputs determines whether the load is on or off.

In a typical solid-state relay, the control voltage is electrically isolated from the ac switching circuits, which contain an optically-isolated triac or similar device. Many solid-state relays also include zero-switching circuits that reduce noise by switching power only when the ac signal is near 0 volt.

In Fig. 2, with a normally-open relay, the load switches on when D0 is low. If you want a logic high at D0 to turn on the load, use a 74LS240, which has inverters, or use a normally-closed relay.

Using a solid-state relay saves you the trouble of building a similar circuit from discrete components. Sur-

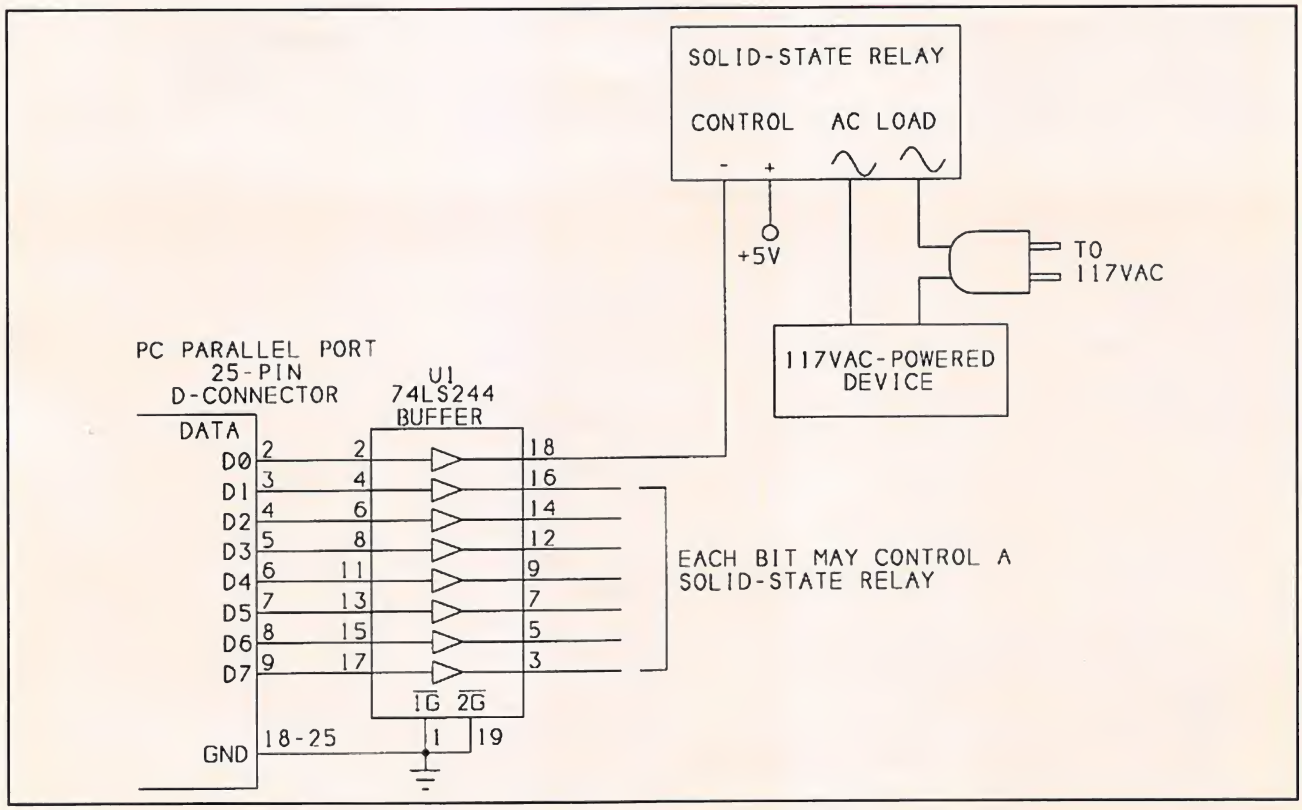


Fig. 2. A solid-state relay is a simple way to control ac voltages and high currents with digital logic.

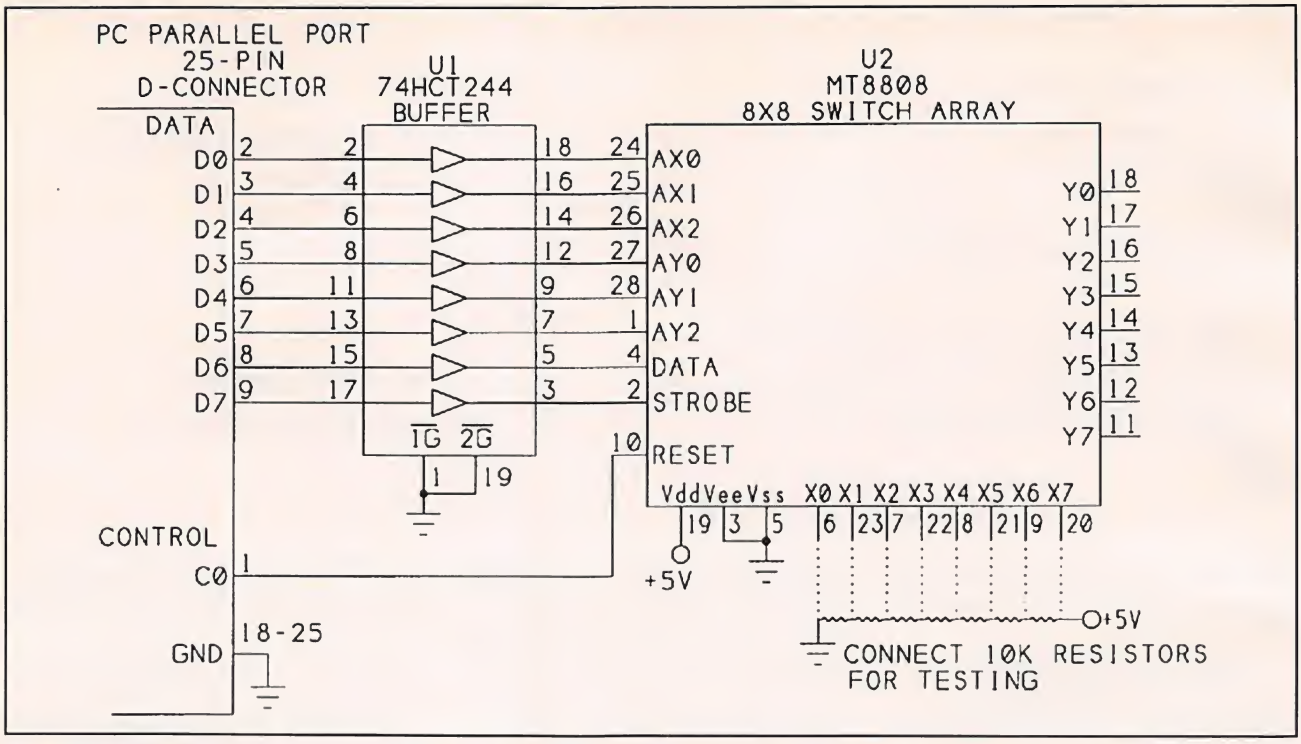


Fig. 3. With this switch array, you can route eight analog or digital signals along any of eight signal paths, in any combination.

plus relays are inexpensive, costing as little as $1.50 each, from vendors like All Electronics, Marlin Jones and Hosfelt. If you don't have a data sheet for your relay, look for a pair of control pins, usually labeled + and –. The other two pins connect to the ac load.

For use with a 74LS244, look for a relay with a control potential of 5 volts or less and input control current of 15 mA or less. The relay's rated output voltages and currents should be greater than those of the load you intend to switch. There are also solid-state relays for switching dc loads at high voltages or currents.

You can control a relay from any of the parallel port's data or control bits or from the any of the expanded outputs in Fig. 1. Just write a 1 or 0 to the corresponding bit to switch the load on or off.

Controlling a Switch Matrix

Figure 3 illustrates how you can use

Listing 2. Test Program For Fig. 2 Circuit

```
'switch matrix
DataPort = &H3BC                                    parallel port
ControlPort = DataPort + 2
ControlMask = &HB                                   'reinverts C0,C1,C3

OUT ControlPort, 0 XOR ControlMask                  'remove reset
OUT DataPort, 0                                     'ensure that STB is low
DO

                                                    PRINT "Enter inputs to connect: "
                                                    INPUT "X (0-7)? ", x
                                                    INPUT "Y (0-7)? ", y
                                                    INPUT "Open (0), close (1), or reset all (2)? ", z
                                                    SELECT CASE z
                                                    CASE 2

      OUT ControlPort, 1 XOR ControlMask            'C0=1 resets switches
      OUT ControlPort, 0 XOR ControlMask            'bring reset low again
   CASE 0, 1
      SwitchData = x + y * 8 + z * &H40             'calculate D0-D6 for address & switch state
      OUT DataPort, SwitchData                      'write address and switch state 'to D0-D7
      OUT DataPort, SwitchData + &H80q'bring STB (D7) high
      OUT DataPort, SwitchData                      'bring STB low to latch data
 END SELECT
LOOP
END
```

Listing 3. Test Program For Fig. 4 Circuit

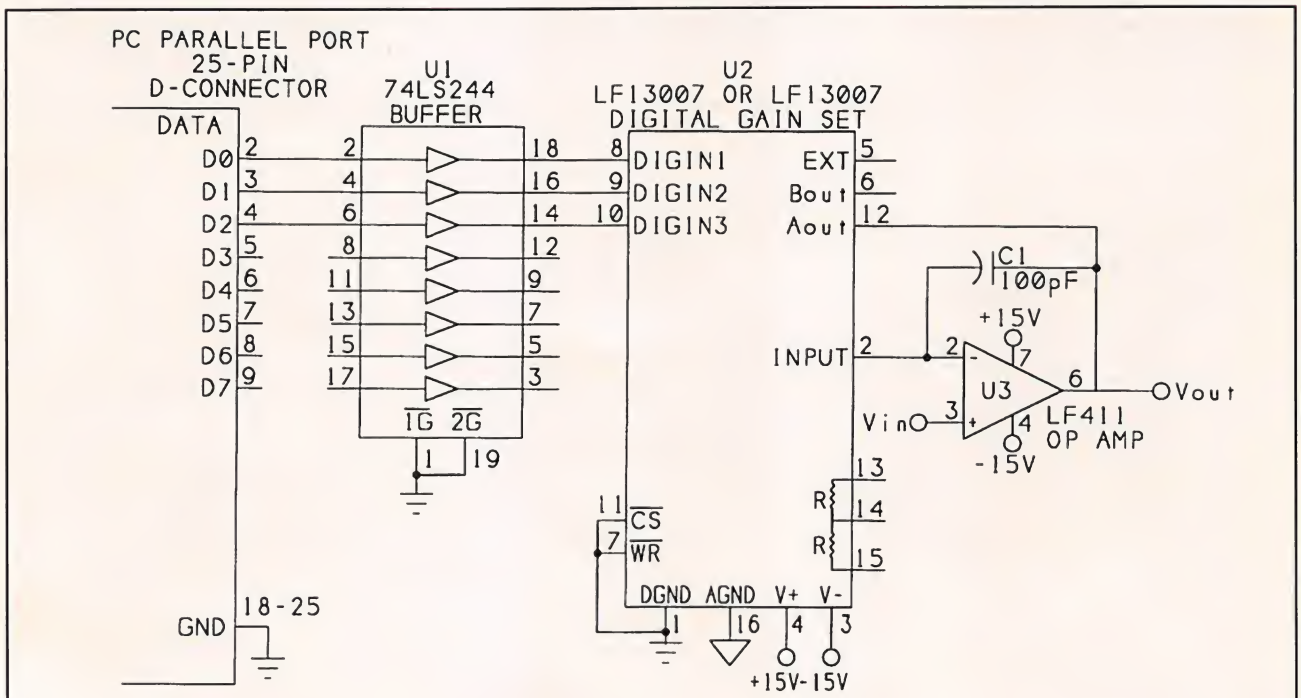
```
'op amp with programmable gain

DataPort = &H3BC                          'set to match the address of your parallel port
DO
    FOR i = 0 TO 7
        OUT DataPort, i                   'write gain to D0-D2
        PRINT "Gain = ",i
        PRINT "Press any key to continue..."
        DO: LOOP WHILE INKEY$ = ""
    NEXT i
LOOP
END
```

the parallel port to control an 8 X 8 array of electronic switches. You can connect any of eight X inputs to any of eight Y inputs, in any combination. Possible applications include switching video or audio signals to different monitors or recording instruments, selecting inputs for test equipment and any situation that requires flexible, changeable routing of analog or digital signals.

A Mitel MT8808 8 X 8 analog switch array simplifies the circuit design and programming. This chip contains an array of crosspoint switches, plus a decoder that translates a six-bit address into a switch selection, and latches that control the opening and closing of the switches. The chip is available from Pure Unobtainium.

Connecting an X and Y input requires the following steps: Write the X and Y addresses to AX0 through AX2 and AY0 through AY2. Bring



GAIN TABLE

DIG IN 1	DIG IN 2	DIG IN 3	GAIN LF13006 Aout	GAIN LF13006 Bout	GAIN LF13007 Aout	GAIN LF13007 Bout
0	0	0	1	1	1	1
0	0	1	2	1.25	1.25	1
0	1	0	4	2.5	2	1.6
0	1	1	8	5	5	4
1	0	0	16	10	10	8
1	0	1	32	20	20	16
1	1	0	64	40	50	40
1	1	1	128	80	100	80

Fig. 4. Three bits set the gain of this operational amplifier. Four series of gains are available, depending on gain-set chip and output used.

Listing 4. Test Program For Fig. 5 Circuit

```
'stepper motor

DataPort = &H3BC                                    'set to match address of your parallel port

DO
    INPUT "Speed (1-15)? ", Speed
    INPUT "Mode (1=wave, 2=2-phase, 3=half-step, 4=stop)? ", Mode
    INPUT "Direction (0=Clockwise, 1=Counterclockwise)? ", Direction

    IF Mode = 1 THEN ModeSet = 4                    'match mode to required values at D4-D6
    IF Mode = 2 THEN ModeSet = 0
    IF Mode = 3 THEN ModeSet = 2
    IF Mode = 4 THEN ModeSet = 6

    Motorcontrol = Speed + (ModeSet + Direction) * &H10
    OUT DataPort, Motorcontrol                      'write motor-control data to D0-D7
LOOP
END
```

STB high. Bring DATA high to close the switch. Bring STB low to latch the data. To open a connection between an X and Y input, do the same but bring DATA low to open the switch.

You can make and break as many connections as you want by writing the appropriate values to the chip. All previous switch settings remain until you change them by writing to the specific switch.

You can connect the switches in any combination. For example, you can connect one X input to each of the eight Y inputs, to create eight distinct signal paths. Or you can connect all eight Y inputs to a single X input to route one signal along eight different paths.

The MT8808 is shown powered at 5 volts dc, but V_{dd} can anywhere from

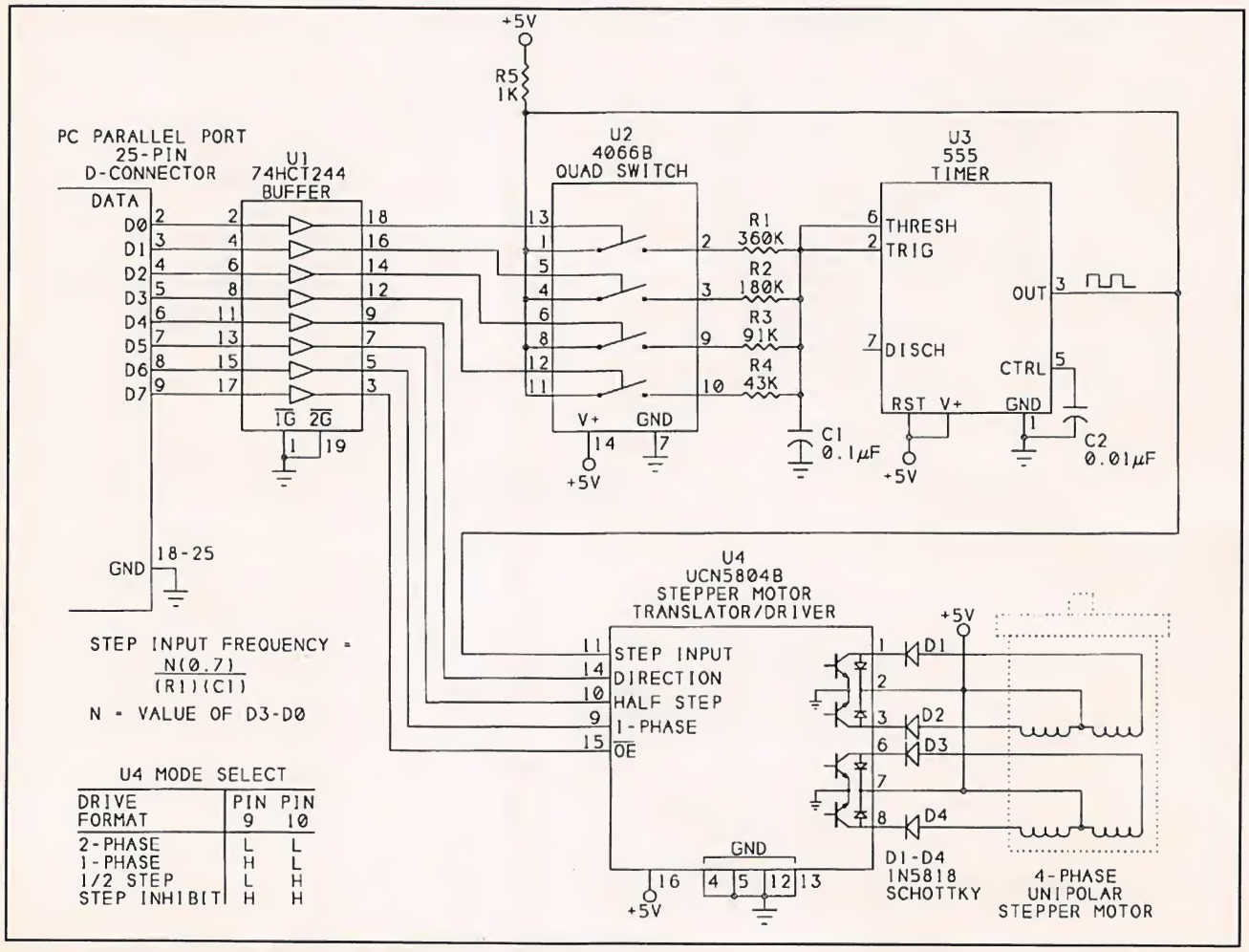


Fig. 5. This circuit uses the parallel port to select a speed, direction and operating mode for a stepper motor.

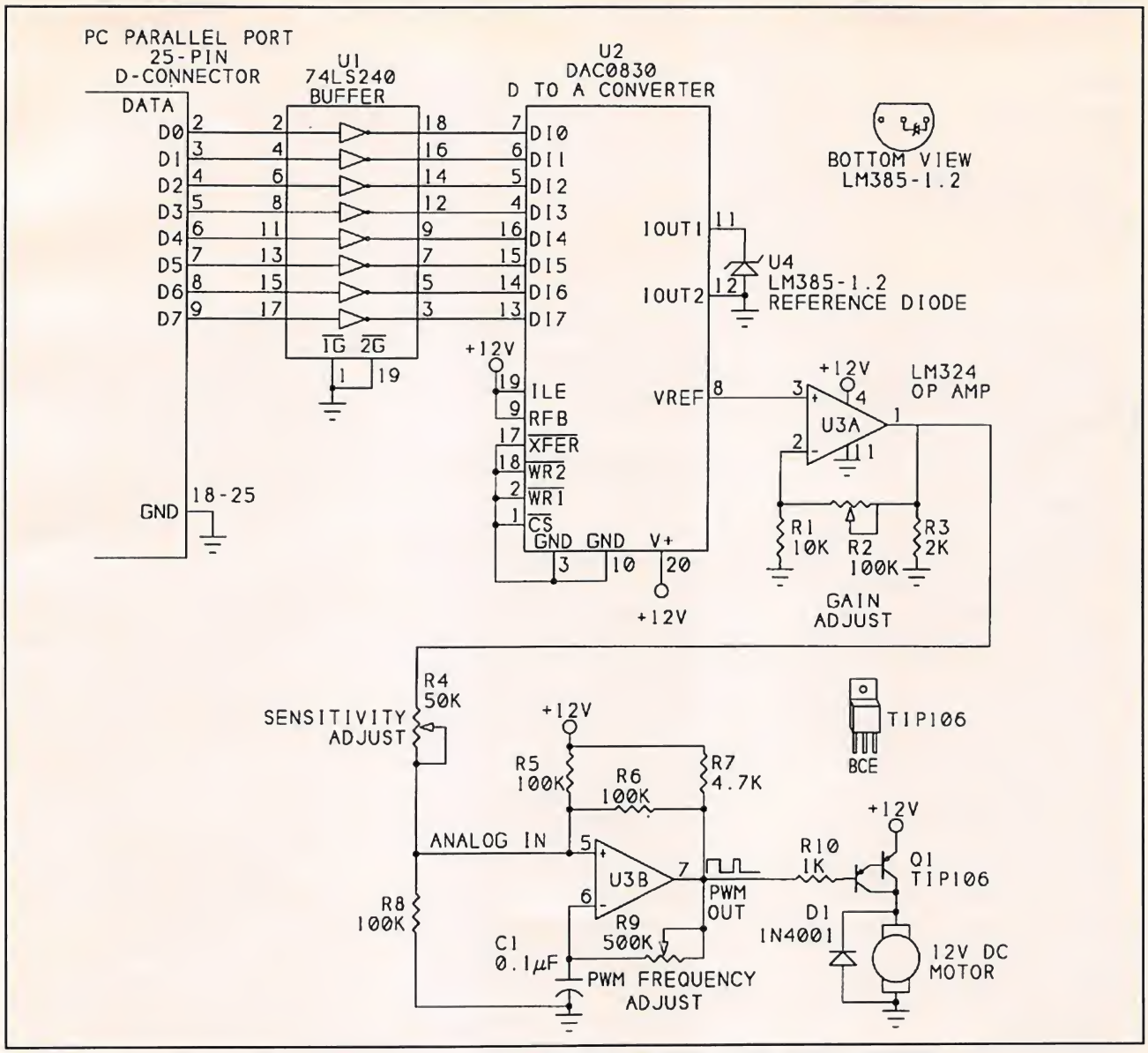


Fig. 6. The dc motor in this circuit has 256 selectable speeds, determined by the value written to the parallel port.

4.5 to 13.2 volts. V_{ee} is an optional negative supply that enables you to switch negative signals.

The switches do have some resistance, which varies with the supply voltage. At 5 volts, typical switch resistance is 120 ohms, while at 12 volts, it drops to 45 ohms. This should cause no problems in switching standard LSTTL and CMOS signals. If you're routing an analog signal to a low-impedance input, switch resistance may attenuate the signal. Maximum switching frequency of the chip is 20 MHz.

In Figure 3, the parallel port's D0 through D7 lines control the switch array. Bringing C0 high opens all of the switches. If you don't need this ability, you can tie RESET low and leave C0 open.

Buffer *U1* is a 74HCT244 that has TTL-compatible inputs and CMOS-compatible outputs. If you instead use a 74LS244, add a 10,000-ohm pull-up resistor from each output to +5 volts to ensure that logic highs meet *U2*'s 3.3-volt minimum requirement. The 74LS244 has the advantage of Schmitt-trigger inputs and so may be less sensitive to noise. A third option is a 74HC244, which requires pull-ups at the inputs unless you're sure that D0 through D7 on your parallel port pull up to at least 3.5 volts.

For a simple test of the switches, you can connect a series of equal-value resistors as shown to the X inputs. Each X input will then be at a different voltage. To verify a switch closure, measure the voltages at the selected X and Y inputs. They should match.

Listing 2 demonstrates switch operation by prompting you for two inputs and asking you whether to open or close the connection. A subroutine resets all switches.

Op Amp with Programmable Gain

In Fig. 4, three data bits are used on the parallel port to set the gain of an operational amplifier. Controlling the gain is National Semiconductor's LF13006 or LF13007 digital gain set

Listing 5. Test Program For Fig. 6 Circuit

```
'dc motor

DataPort = &H3BC                                    'set to match address of your parallel port

DO
    INPUT "Enter a speed from 0 to 255: ", Speed
    OUT DataPort, Speed
LOOP
END
```

IC (available from Digi-Key and others). Each contains a resistor ladder, switches and decoding logic that enable you to select any of eight gains for an amplifier, attenuator, current source or other circuit that requires precise, variable outputs.

Each gain-set IC has two outputs, each with a different series of gains, shown in Fig. 4. Gain error is guaranteed to be 0.5% or less over the full range of operating temperatures.

Lines D0, D1 and D2 on the parallel port set the gain at DIG1, DIG2 and DIG3. The Chip-Select and Write pins on *U2* are tied low, which causes the gains at pins 12 and 6 to immediately match DIG1, DIG2 and DIG3.

If you want to control up to four gain-set chips and op amps, you can use D3 through D7 to select the desired chip. Tie all of the –WR inputs to D7, and tie each –CS input to a unique data output (D3 through D6). Then, to set the gain of an op amp, bring its –CS input low, then bring –WR low then high to latch the data to the desired chip.

You can use just about any op amp at *U3*. Shown is an LF411, which has wide bandwidth and low input offset and drift.

A 10-pF capacitor from the op amp's input to its output adds stability, as recommended in the LF13006/7's data sheet. I found that the capacitor did keep the op amp's output from oscillating at certain gain settings.

Chip *U1* buffers D0, D1 and D2. Chip *U2* TTL-compatible data inputs and has two matched, uncommitted resistors of about 15,000 ohms value each that you can use as you wish.

Listing 3 steps through the available gains. You can verify circuit operation by connecting a signal like a sine-wave output of a signal generator to pin 3 of *U3* and monitoring pin 6 of *U3* with an oscilloscope or voltmeter. To use the full range of gains, the signal at pin 3 must be quite small. For example, if your input is 100 mV peak-to-peak, at a gain of 128 the output is 12.8 volts.

Easy Stepper-Motor Control

In Fig. 5 is shown a parallel port controlling a four-phase unipolar stepper motor. To control a stepper motor, you must apply a specific sequence of pulses to each of its phases, or coils. You can choose from several modes of operation, with each using a different sequence of pulses. The frequency and sequence of the pulses determines the speed of the motor.

After you write values to the parallel port to set the speed and operating mode in the Fig. 5 circuit, the motor continues to run automatically, using the selected parameters. This frees your computer to do other things without having to worry about generating the signals to control each step of the rotation.

The circuit uses a UCN5804B stepper-motor translator/driver from Allegro Microsystems (formerly Sprague). The chip automatically creates the drive signals for operation in any of three modes. Pure Unobtainium carries this and other Allegro chips.

4066B CMOS quad switch *U2* enables you to select any of 15 speeds. Timer *U3* outputs a square wave in proportion to the selected speed, for use by driver *U4* in timing the steps. The four outputs of *U4* can sink up to 1.5 ampere each and sustain up to 35 volts. The chip includes diodes that protect against inductive transients and thermal protection that disables the outputs if the chip begins to overheat. For high output currents, use a slide-on DIP heatsink to prevent overheating.

The motor is a four-phase unipolar type with six leads that connect to two sets of coils. Two coils are in each set. Surplus motors often don't include complete documentation, but you can sort out the leads with an ohmmeter and some experimenting. Begin by looking for a lead that connects through an equal resistance (typically 5 to 50 ohms) to two other leads. Wire this lead to +5 volts and pin 2 of *U4*. Wire the two leads that connect to this lead to pins 1 and 3 of *U4* through diodes *D1* and *D2*. Swapping the leads at pins 1 and 3 reverses the direction of the motor. Identify and wire the remaining three leads in the same manner, but using pins 6, 7 and 8 of *U4*.

The 5-volt motor is powered directly by a 5-volt supply. This simple drive circuit is fine for many applications, especially at lower speeds. You can find examples of other drive circuits in Airpax's *Stepper Motor Handbook* or similar documentation from other motor manufacturers.

Schottky diodes *D1* through *D4* are recommended in the data sheet to prevent problems in the logic circuits due to mutual coupling in the motor windings. Schottky diodes have a smaller forward voltage drop (0.25 volt) than is the case for other silicon diodes.

Resistors *R1* through *R4* and capacitor *C1* determine the frequency of *U3*'s output signal.

To select a speed, you write a number from 1 to 15 to the parallel port's D0 through D3 lines. Each bit controls one of *U2*'s switches. For example, when D0 is high, pins 1 and 2 of *U2* connect and *R1* is one of *U3*'s timing components. When D0 is low, pins 1 and 2 of *U2* are open and *R1* has no effect on *U3*. When more than one switch is closed, the parallel combination of resistors forms the timing resistance. When all switches are open, *U3*'s output is high and the motor is brought to a stop.

In addition to the frequency of the step input, motor speed depends on

the step angle of your motor and the mode selected at *U4*. A typical motor has a step angle of 18° and requires 20 steps (360/18) for one full rotation. Using the resistor values shown and a motor with an 18° step angle, the motor speed will vary from 1 to 15 Hz in wave-drive or one-phase mode.

For a different range of speeds, use the formula shown to select resistor and capacitor values. For speeds from 10 to 150 Hz, use a 0.01-µF value for *C1* or decrease the values of *R1* through *R4* by a factor of 10. The formula assumes that in the series *R1* through *R4*, each resistor has half the value of the preceding one. If you use a different resistor scaling, you'll have to calculate the values of the parallel combinations of resistors to find the resulting frequencies.

Bits D5 and D6 select the operating mode. Wave-drive mode powers one phase at a time, while two-phase drive powers two phases at once and half-step drive alternates powering one and two phases. Wave drive uses the least power, but with reduced torque compared to two-phase drive. Half-step drive uses twice as many steps per revolution, and so offers finer control.

Bit D4 sets the direction of rotation. You can stop the motor in any of three ways. You can bring D0 through D3 low to stop the timer. You can bring D7 high, which removes power from *U4*'s outputs. Or, you can bring pins 9 and 10 of *U4* high, which continues to apply power to the motor but ignores the step input.

Chip *U1* buffers the signals from the parallel-port cable. Logic highs at the inputs of *U2* and *U4* must be at least 3.5 volts. Therefore, add pull-ups if you use an LSTTL buffer.

Listing 4 prompts you for a motor speed, mode of operation and direction and then runs the motor as requested. You can stop the program, and the motor will continue to run as long as it's connected to the parallel port and you don't write anything else to the port.

Speed-Controlled DC Motor

If you prefer ordinary dc motors to steppers, Fig. 6 shows a circuit that has a range of 256 user-selectable

Sources

Airpax Co.
604 West Johnson Ave.
PO Box 590
Chesire, CT 06410
Tel.: 203-271-6000; fax: 203-271-6400

CIRCLE NO. 120 ON FREE INFORMATION CARD

Allegro Microsystems
115 Northeast Cutoff, Box 15036
Worcester, MA 01615
Tel.: 508-853-5000; fax: 508-853-7861

CIRCLE NO. 121 ON FREE INFORMATION CARD

All Electronics Corp.
PO Box 567
Van Nuys, CA 91408-0567
Tel.: 1-800-826-5432 or 818-904-0524; fax: 818-781-2653

CIRCLE NO. 122 ON FREE INFORMATION CARD

Digi-Key Corp.
701 Brooks Ave. S.
PO Box 677
Thief River Falls, MN 56701-0677
Tel.: 1-800-344-4539; fax: 218-681-3380

CIRCLE NO. 123 ON FREE INFORMATION CARD

Hosfelt Electronics
2700 Sunset Blvd.
Steubenville, OH 43952-1158
Tel.: 1-800-524-6464 or 614-264-6464; fax: 614-264-5414

CIRCLE NO. 124 ON FREE INFORMATION CARD

Marlin Jones & Associates
PO Box 12685
Lake Park, FL 33403-0685
Tel.: 407-848-8236; fax: 407-844-8764

CIRCLE NO. 125 ON FREE INFORMATION CARD

Mitel Semiconductor
PO Box 13089
Kanata, Ontario K2K 1X3, Canada
Tel.: 1-800-267-6244 or 613-592-2122

CIRCLE NO. 126 ON FREE INFORMATION CARD

National Semiconductor Corp.
2900 Semiconductor Dr.
PO Box 58090
Santa Clara, CA 95052-8090
Tel.: 1-800-272-9959 or 408-721-5000

CIRCLE NO. 127 ON FREE INFORMATION CARD

Pure Unobtainium
13109 Old Creedmoor Rd.
Raleigh, NC 27613
Tel.: 919-676-4525

speeds for a 12-volt dc motor. You select the speed by writing a byte to D0 through D7.

Digital-to-analog converter *U2* translates the byte to an analog voltage. Op amps *U3A* and *U3B* amplify the voltage and create a pulse-width-modulated (PWM) output whose duty cycle varies in proportion to the analog voltage, respectively. The PWM signal controls a transistor that drives the motor. All components are powered at 12 volts, except *U1*, which requires a 5-volt supply.

Chip *U2* is used in its voltage-switching configuration in which the output at V_{ref} varies from 0 volt to 255/256 V_{ref}. V_{ref} is obtained with an LM385 1.2-volt reference diode or another stable voltage reference. The potential on pin 8 of *U2* varies from 0 to 1.2 volts, in proportion to the value at DI0 through DI7. For best results, the data sheet recommends using a V_{ref} of less than 5 volts and at least 9 volts less than the supply voltage.

Chip *U2* is configured for flow-through operation in which V_{ref} continuously reflects the value at D0 through D7. If you want to control up to four motors, you can connect one of the parallel port's control outputs to pin 2 (-WR1) of each DAC0830. Then, after writing the desired byte to the data port, you'd latch the data to the desired DAC by bringing its -WR1 input low and then high.

Chip *U1* buffers and inverts the signals from the parallel port. The data inputs of *U2* are TTL-compatible.

The duty cycle at the PWM OUT of oscillator *U3B* varies with Analog In. Duty cycle is the ratio of "on time" per cycle to total cycle time. When pin 7 of *U3B* is low, transistor *Q1* is on and the motor is powered. When pin 7 is high, *Q1* is off.

As shown, when D0 through D7 equals 255, Analog In is zero and PWM OUT consists of wide low pulses alternating with short high pulses; so motor speed is fast. As you decrease the value at D0 through D7, Analog In increases, the percentage of time PWM OUT is low decreases, and motor speed slows. If you use a (non-inverting) 74LS244 at *U1*, motor speed increases as Analog In decreases.

Chip *U3B*'s output has a 50% duty cycle (equal high and low pulses) when Analog In is 6 volts, or half the supply voltage. Adjusting *R2* varies the value at D0 through D7 that results in a 50% duty cycle.

Adjusting *R4* varies the sensitivity of PWM OUT to changes in D0 through D7. Decrease *R4* for a wider range of duty cycles (and speeds), and increase *R4* for a narrower range.

The frequency of *U3B* varies inversely with *R9* and *C1*. You can experiment with different frequencies to find one that works well for your motor and application.

A Darlington transistor is shown for *Q1*, but you can use any pnp transistor that has sufficient gain and power rating to drive your motor. Diode *D1* protects against inductive transients.

Listing 5 asks you to enter a motor speed and then writes this value in to the data port to control the motor.

The foregoing is just one way to control dc motor speed from a parallel port. Another approach would be to generate the PWM signal in software, eliminating the need for *U2*, *U3* and *U4*, but at the expense of more-complex programming and greater use of computer resources. Alternatively, you could program a microcontroller to generate the PWM signal, with speed set according to data written to it from the parallel port. If you want to be able to reverse motor direction, use an H-bridge configuration instead of the single transistor. Allegro Microsystems' UDN2993 chip is an easy way to do this.

Next time, I'll give you a look at some ideas for detecting and measuring using the parallel port's input pins, and more. ■

You can reach me on CompuServe at 71163,3555, on Internet at 71163.3555@compuserve.com or by mail at Box 3374, Madison, WI 53704-0374. For a personal reply by mail, please include a self-addressed envelope, stamped envelope.

Jan Axelson

By Tom Benford

Beyond Double-Speed and Single Discs: Pioneer Breaks the CD-ROM Bottleneck

An in-depth look at Pioneer's DRM-604X CD-ROM mini-changer drive with six-disc magazine

If you're a power PC user who needs access to lots of CD-ROM-based information in a hurry and can afford the cost, Pioneer has an appealing solution for you in its new quadruple-speed DRM-604X CD-ROM mini-changer drive. After putting this drive through its paces on the test bench and in practical applications, I can tell you that I'm very impressed. I don't hesitate to tell you that, whatever your needs, this is one PC peripheral you just have to look into if you want top-drawer information-retrieval performance from a CD-ROM.

This article gives you an in-depth look at Pioneer's DRM-604X mini-changer drive and compares it to its nearest competition, NEC's latest triple-speed-plus MultiSpin 3x series of drives, to provide you with a perspective on what you can expect from the DRM-604X's state-of-the-art features and performance. Before I get into what makes the DRM-604X so remarkable and how it achieves it's extraordinary speed, a discussion of CD-ROM drive speeds in general and double-speed in particular is in order.

Drive-Speed Basics

Data on a CD (or CD-ROM) is written in a long spiral track that starts at the center and works its way outward toward the edge of the disc. Because of this arrangement, the disc must rotate faster when it's accessing data nearer its hub than when data is being read closer to the outer edges to keep data flowing at the same steady rate. CD-ROM drives (and CD audio drives, for that matter) are CLV (constant linear velocity) devices that adjust their rotational speed to keep the data-transfer rate constant at a steady 150K per second, the standard speed for audio CD playback. Since all computer CD-ROM drives are also capable of playing audio CDs, this standard "single speed" is a mandatory prerequisite to maintain this ability.

```
The CD-ROM Device Driver Ver 1.10
for MSCDEX Ver.2.10 - IBM PC-XT/AT
& AX, Future Domain
Copyright(c)Pioneer Electronic
Corporation
          Inquiry ID=0:PIONEER CD-
ROM DRM-604X 2401

The LDP/CDP Device Driver for SCSI
model Ver. 1.03
Copyright(c)Pioneer Electronic
Corporation. 1990

MSCDEX Version 2.21
Copyright(c)Microsoft Corp.
1986,1987,1989. All rights res.
Drive D:   =   Drive MSCD000 unit 0
Drive E:   =   Drive MSCD000 unit 1
Drive F:   =   Drive MSCD000 unit 2
Drive G:   =   Drive MSCD000 unit 3
Drive H:   =   Drive MSCD000 unit 4
Drive I:   =   Drive MSCD000 unit 5
```

Fig. 1. Upon boot-up, the system in which the DRM-603X is installed takes "inventory" of the six logical devices all assigned to one SCSI ID and displays a screen message similar to this.

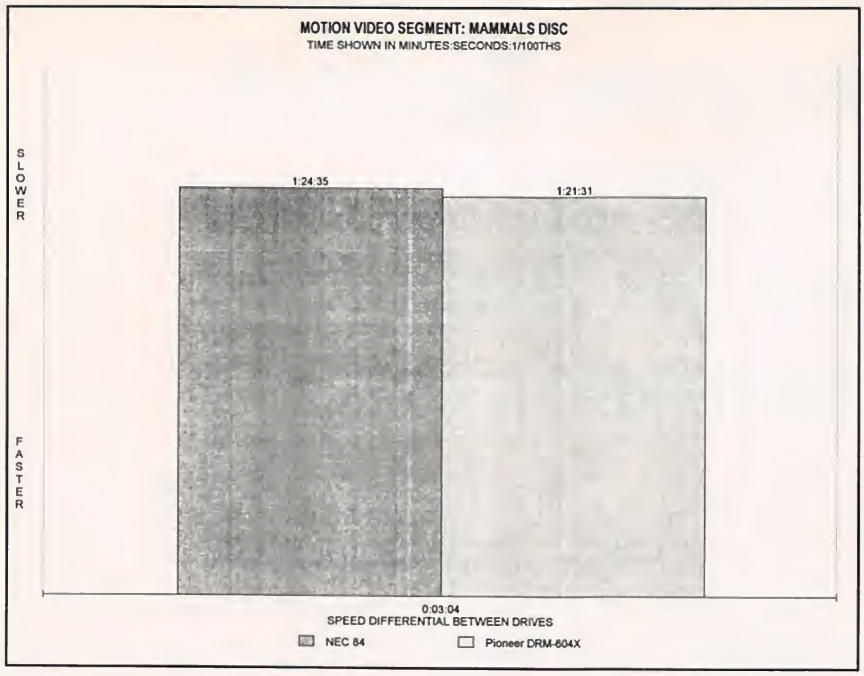
The reason for a 150K/s transfer rate is that if audio data is accessed at faster than single-speed, the result would be much like playing a 33-rpm record at 45 or even 78 rpm. The pitch, tempo and sound would be adversely affected. This 150K/s rotational speed was established back in the early days of CD audio by the major manufacturers so that all CDs would sound as they should, regardless of the CD player on which they were played. The specification is incorporated into what's known in the industry as the Redbook Standard.

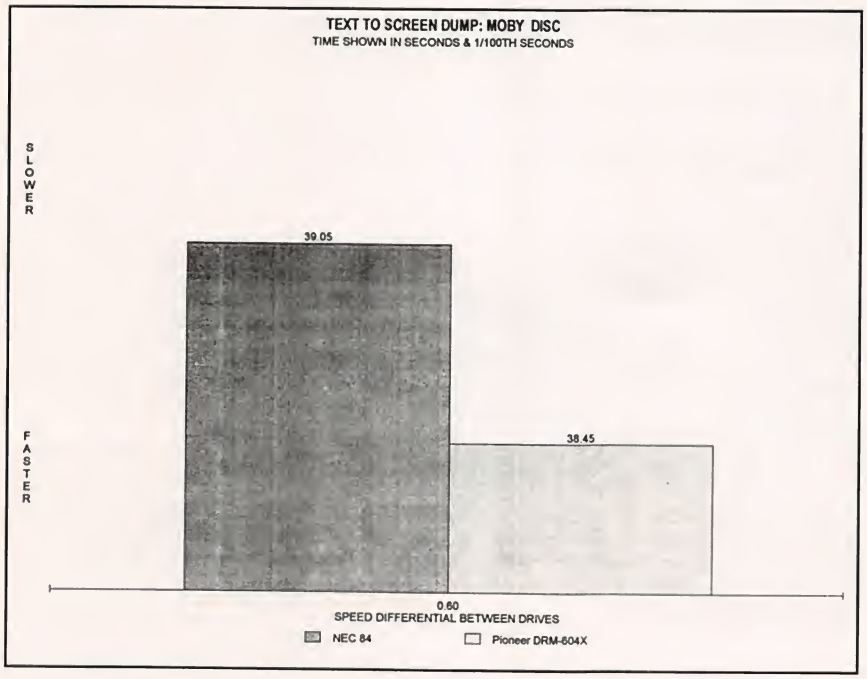
Since computer data—which consists of text, graphic images, .WAV and MIDI data and even full-motion video data—doesn't have the same aural constraints as audio data, it can be retrieved and transferred at much faster speed. This is what gave rise to CD-ROM drives that exceed single-speed operation. From an engineering standpoint, the easiest way to increase the speed of a drive was to double it through mechanical (pulleys/gears) or electronic (faster motor speed) means. This still permits the drive to play audio discs at the single-speed rate by "downshifting" the speed when this function is called.

The term "double-speed" refers to the actual rotational speed of the drive spindle —the mechanism that engages the hole in the middle of the disc and spins it. As the rotational speed of the disc is doubled, so is its data-transfer rate from 150K/s to 300K/s.

While a transfer rate of 150K/s is fine for playing audio CDs and accessing text and graphic files, it's woefully inadequate for delivering the vast amounts of data (that usually combine text, graphics, music and even animation or full-motion video) in today's multimedia applications; faster rotational speeds delivering faster data transfer rates are no longer a luxury. In fact; they've become mandatory for any kind of multimedia work.

Ostensibly, if double-speed is good, data transfer speeds that exceed 300K/s are better. In actual practice, this is true, although the perceived benefits of this enhanced performance are highly dependent on the type of data you're accessing. For example, faster data-transfer rates produce smoother full-motion video and animation playback, although speed increases for retrieving text-based data can be negligible to marginal in some cases. As a general rule, though, the faster the rotational speed/data-transfer rate, the better and





quicker the drive performs.

Now that you have a basic understanding of single- and double-speed drives, I'll examine the Pioneer DRM-604X, a quadruple-speed drive that delivers a data-stream rate in excess of 600K/s. And if speed alone isn't enough to bedazzle you, consider the fact that the DRM-604X drive accommodates *six* discs at a time.

The Phoenix Rises

The DRM-604X is a slightly smaller incarnation of its older sibling, the trusty (albeit slow) DRM-600, Pioneer's original six-disc mini-changer CD-ROM drive that made its appearance about four years ago when CD-ROM was a fledgling technology. Though the 604X is the same width as the 600, it's about 1/2" squatter and about 1 1/4" shorter than its predecessor, with overall measurements of (13 3/4"D X 8 1/4"W X 4"H. There are some subtle differences that immediately set the two drives apart when making side-by-side comparisons

In additon to Power, Busy and Audio LEDs located on the front panels of both models, the DRM-604X has an additional LED that signifies when the drive is in its "X4" (Quadraspin) mode. A pushbutton power switch is also mounted on the front panel of the 604X, whereas the 600 has a rocker-type power switch located on its rear panel. Pioneer has retained the same location on the front of the new drive as on the older model for the eject switch and the stereo miniature phone jack with rotary headphone volume control knob, making these items easily accessible to the user.

Other design changes are also found at the rear of this multi-disc drive. A six-position DIP switch is mounted between dual SCSI jacks. Positions of these switches select the operational modes as follows:

Switch	Function
1	Buffer Size: On/Off 512K/2,048K
2	Parity Check
3	Fixed Standard Speed
4	SCSI 2 Command Set
5	Reserved
6	Disable Eject Switch

For selecting the SCSI device ID, a pushbutton selector switch has been added just below the DIP switch bank. On the 600 model an eight-position DIP switch is used for selecting the device ID, as well as all other operational parameters.

Another new feature on the 604X is a slider switch that turns on and off the built-in terminator, thus negating the need to use a plug-in terminator when SCSI termination is required. A thumb-screw grounding post is on the rear of the unit, next to the socket for the detachable power cord, as are the right and left phono-type audio line output jacks. These jacks are next to each other (horizontal placement) on the 604X, but they're vertically mounted on the DRM-600.

The standard PC interface kit recommended by Pioneer and supplied with the review unit I used is an optional $200 item, the Future Domain FDC-16. This SCSI interface is a 16-bit card that plugs into any available half-to-full-length expansion slot. A SCSI interconnect cable that has a 25-pin D-shell connector at one end and a standard SCSI edge connector at the other end is supplied with the card. This cable bears a bright orange label printed with the warning that it's "for use with Apple pinout-SCSI port only." Similarly, the backplane mounting bracket of the interface card bears a label stating that it's an "Apple Signal SCSI port."

The warning labels shouldn't be taken lightly because damage to the interface card and possibly to the drive as well can result from using a SCSI cable that isn't wired to the Apple SCSI pin arrangement. At the very least, the drive won't respond correctly (if at all) if a standard PC SCSI cable is used. (For the purposes of the

speed-comparison tests I ran, however, I used an Adaptec 1540 16-bit SCSI interface for both the Pioneer and NEC drives).

Three software diskettes that contain utilities and drivers are provided with the DRM-604X drive. The IBM/DOS programs are supplied on both 3½" and 5¼" media, while the Macintosh software comes on a single 3½" diskette.

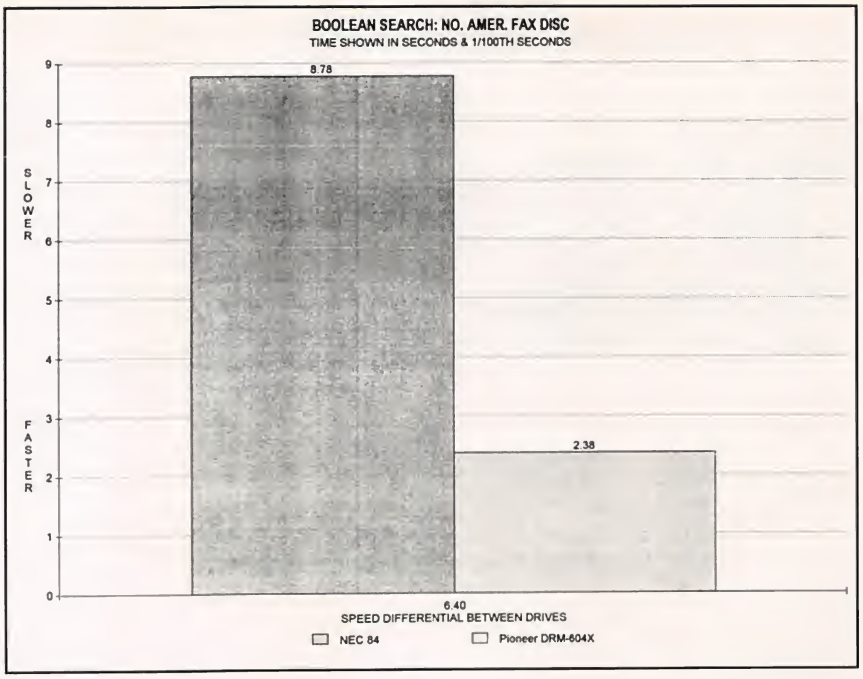
Setting up the software is a highly automated procedure that's effected by running the INSTALL.COM program (the installation manual incorrectly lists this program as SETUP.EXE). Several drivers and utilities are provided on the diskettes for various configurations, in addition to a README.DOC file. These include:

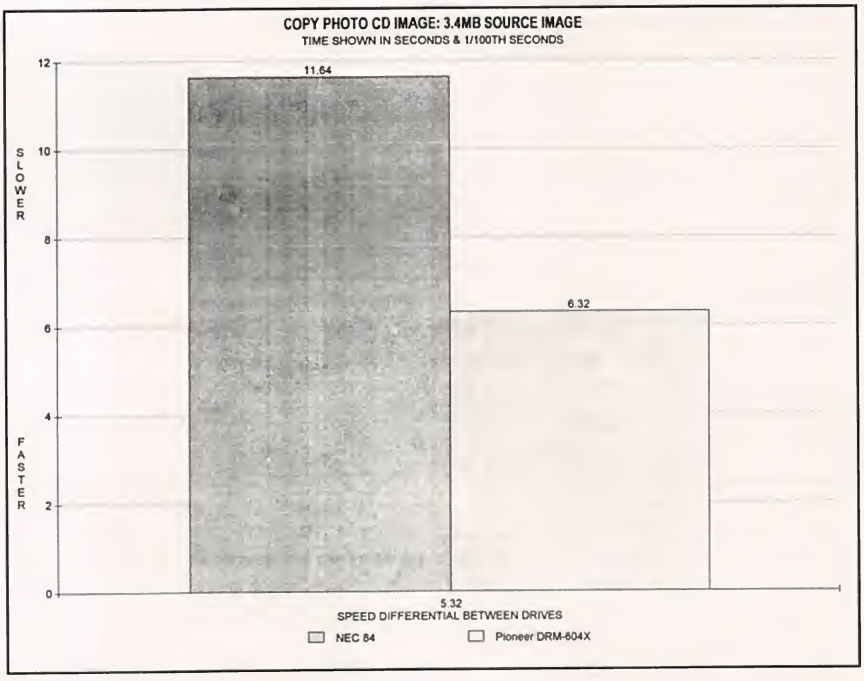
- ***MSCDEX.EXE*** Version 2.21 of the required Microsoft MS-DOS CD-ROM extensions
- ***DRD600.SYS*** device driver for Future Domain SCSI boards (TMC and MCS series eight-bit models)
- ***DRD60PS.SYS*** device driver for IBM SCSI cards on PS/2s
- ***DRD60ASP.SYS*** ASPI (Advanced SCSI Protocol Interface) compatible device driver
- ***ASPIFD.SYS*** ASPI manager for 16-bit Future Domain (or Adaptec or any other ASPI-compliant) interface cards
- ***DISC.EXE*** utility program that permits designating of CD-ROM sub-unit number to be in any desired order (very handy for making the disc designated as DEVICE F respond as if it's loaded in the uppermost DEVICE D position in the six-disc magazine without having to physically re-shuffle the order of the discs)
- ***DRDUTL.EXE*** utility that changes the driver's behavior (mode) to permit optimum performance for any application. You use this utility only when an application program requests a change in the driver's mode (such as to conform to XA data);
- ***MPC.COM*** multi-play TSR (memory-resident) audio controller program for playing CD audio while using the PC for other putposes
- ***MPCRMV.COM*** utility for removing the MPC TSR from memory.

Installation can be completed in well under 15 minutes for both the hardware and software segments, even by a novice user who has little or no technical prowess. The default settings of the Future Domain interface card should work fine for the vast majority of installations, although the installation manual has a good section on troubleshooting if a problem or device conflict is encountered.

For those of you who are multi-platformed, the supplied Macintosh software consist of a Read me file and several extensions. These include:

- ***CLD ACCESS*** device driver for DRM-600 series CD-ROM drives for the Mac operating system to recognize ISO 9660 or High Sierra CD-ROMS or audio CDs;





- ***CLD COMM*** mnemonic command access device driver;
- ***CLD PLAYER*** remote control program for controlling the playback of audio CDs.
- ***ACCESS FILES*** Foreign File Access, ISO 9660 File Access, High Sierra File Access and Audio CD Access. The Mac installation consists of dragging the files from the floppy into the system folder on the startup disk, shutting off the Mac, connecting a SCSI cable to both the Mac and the DRM-604X and making sure the device ID is set to a number between 1 and 6 (the Mac's internal hard drive usually takes ID #0 and the CPU takes ID #7). When these tasks are completed and the drive is powered-on, it will be recognized as a "present device" by the Mac when it is restarted.

I installed the Pioneer drive on my 80486DX/50-MHz system, and I didn't encounter any problems using the default settings. Upon boot-up, the system takes "inventory" of the six logical devices all

Performance Comparison Details for NEC 84 and Pioneer DRM-604X CD-ROM Drives

Test Performed	Results NEC 84	Pioneer DRM-604X	Difference
Mammals Lion Video Segment	1:24:35	1:21:31	0:03:04
MOBY Text File Dump (9000STAR.MOB)	39.05	38.45	0.60
Copy Photo CD File to HD (IMG0030; 3407872 Bytes)	11.64	6.32	5.32
Boolean Search (FAX Book; Exxon NJ Phase)	8.78	2.38	6.40
MPC Wizard Data-Rransfer (K/s)	266	740	474
Video for Windows (CLAYZRD.AVI)	33.9	33.41	0.49
QuickTime for Windows (SPOONMAN)	33.98	33.51	0.47
Uninterrupted Audio Playback (2.1M .WAV File)	Pass	Pass	

assigned to one SCSI ID, and displays a screen message similar to that in Fig. 1.

As you can see from this screen dump, the software assigns each of the six CD-ROMs in the drive's magazine a unique drive ID so that using, for example, the third disc in the magazine merely requires logging onto drive F. Under this arrangement, it is possible to have six of your favorite or most-used discs on-line and available for use at all times.

The DRM-604X's performance exceeded even my most optimistic expectations regarding its speed, and to put it in perspective I decided to run a series of tests to establish some baseline performance parameters with the NEC 84 double-spin drive, one of first and most popular double-speed units available. To keep the playing field "level," I used the same PC system and SCSI interface card; only the CD-ROM drives themselves were changed.

The tests consist of timing several real-world applications using the same system configuration with the exception of the actual CD-ROM drives.

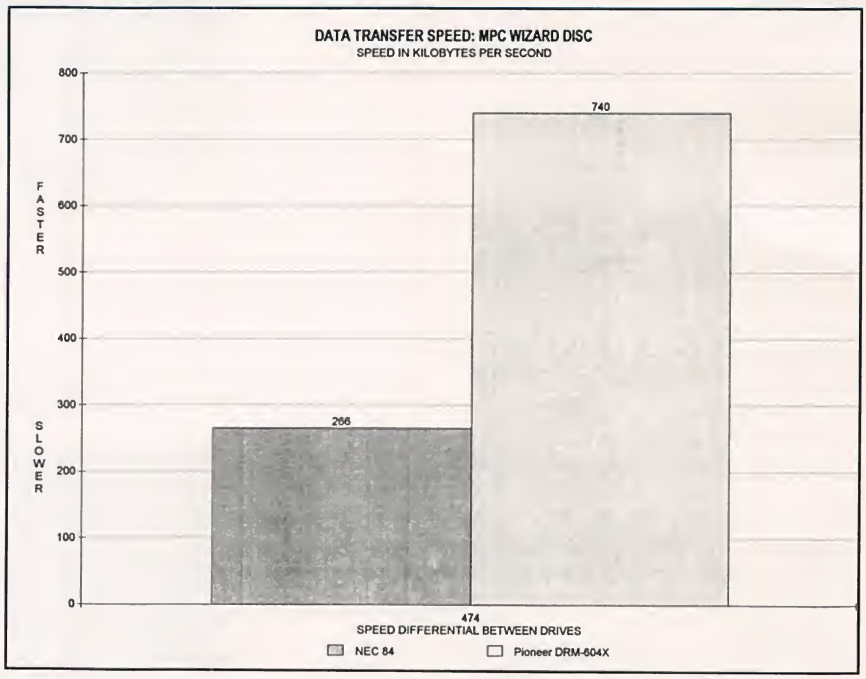
Here's a description of the different tests I performed:

Rolling Video - The "movie" segments of National Geographic's *Mammals* disc are good for testing a drive's sustained data streaming rate, as only the fastest drives can play these segments with smooth motion. The lower the playtime for a segment, the faster the drive is and the smoother the video motion appears onscreen. This test is run under DOS.

Text File Dump - another DOS-based test which times how long it takes to "type" a large text file from Alde Publishing's *Amazing Moby* lexicon disc to the video display of the test system. A software stopwatch program automatically records the elapsed time.

Photo CD Copy - in addition to establishing the drive's ability to read a Kodak Photo CD, this test is run from DOS using a software stopwatch program to automatically time how long it takes to copy a 3,407,872-byte image file to the test system's hard drive.

Database Search - Quanta's *North American Facsimile Book* disc is the database source with its *TextWare* retrieval software. A two-word phrase search is run and the elapsed time recorded.



Data Transfer Test - Aris Entertainment's *MPC Wizard* 1.0 is used under *Windows* 3.1 to report the drives data transfer rate.

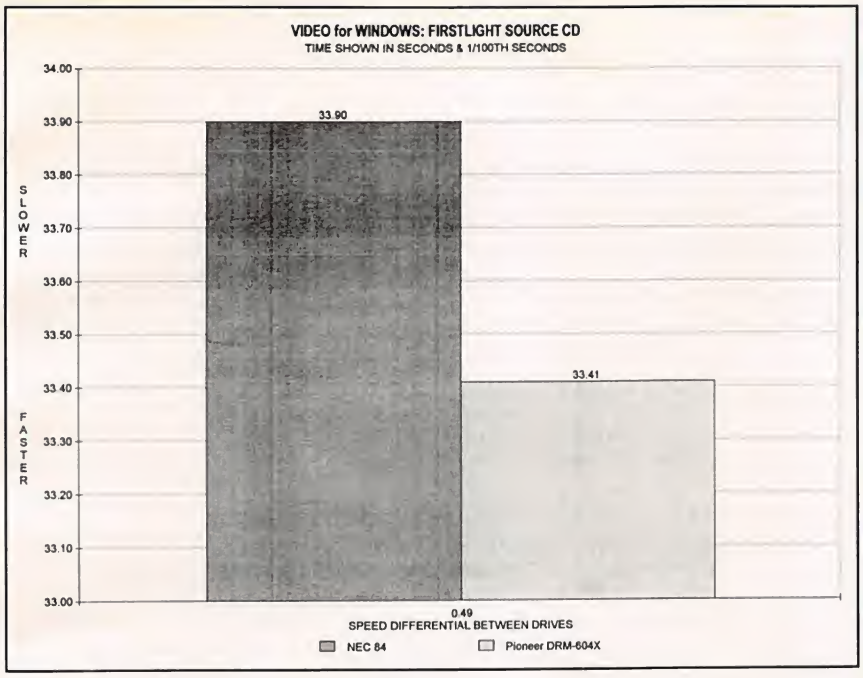
Video for Windows - a sample animation file from Microsoft's *Video for Windows* CD-ROM is used, and the playback time recorded.

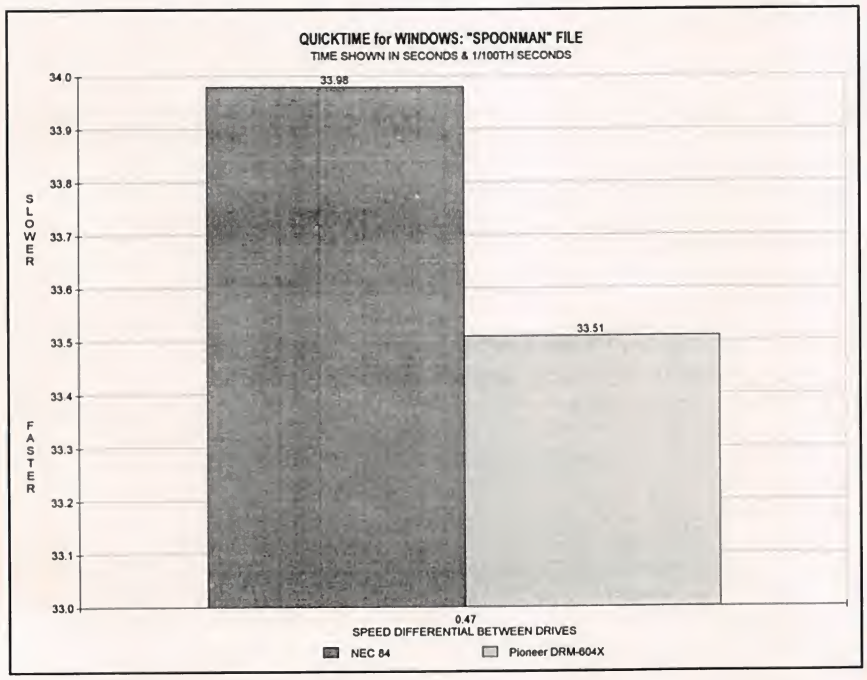
QuickTime for Windows - a sample video clip from Apple's *QuickTime for Windows* CD-ROM provides the source for this test; the playback time for the segment is recorded.

As you can see from the accompanying test results charts, the Pioneer DRM-604X is an absolute screamer, leaving the double-speed NEC CDR-84 in the dust on some of the tests.

This stellar performance is made possible by Pioneer's Quadraspin technology, which rotates the disc at 4X the normal speed, resulting in 612KB/second (or higher, according to *MPC Wizard*) data-transfer speeds. Pioneer's product information claims that new VLSI (very large scale integration) chips, optical head and loading mechanisms were developed to achieve rotational speeds up to 2,100 rpm. The drive is also equipped with a huge 128K buffer for smooth playback of even the most demanding multimedia applications. Reading the data at these extreme speeds is made possible by incorporating a hologram grid and a diffraction grating into the optical read mechanism so that the focus can be maintained on the track and sector being read. The principle and effect are similar to the laser scanners used at your local supermarket's check-out counter.

The benefits of the six-disc magazine are particularly appealing to any user with a stable of "bread-and-butter" CD-ROMs that are used on a frequent or continuing basis. For example, Microsoft *MM Bookshelf*, UniDisc's *CD-ROM Directory* and Meckler's *CD-ROMs in Print* are three discs I use on a daily basis, and it's very convenient to have them all available for instantaneous access whenever needed.





Plus, there are still three trays in the magazine available for loading "transient" discs.

This drive is also an excellent choice for users with multi-volume databases. Since the drive is defined as six logical devices under one SCSI ID, the drive automatically switches discs to find its target. The magazine can be locked in the drive (by disabling the eject switch) for additional data security in multi-user installations.

Overall, the drive performed flawlessly — so well, in fact, that I think this one is going to be a "keeper." The performance the 604X delivers and the convenience its six-disc magazine affords makes it well worth the suggested list price of $1,495, especially since the "street" price for this CD-ROM-rocket is about $1,250.

If that price tag is a little too steep for you, Pioneer has also just released the DRM-602X, a double-speed version of the 604X, with all of the same features except that it's only half as fast. Suggested list for the 602X is $1,095 (street, about $875).

At the other end of the spectrum, you can still have quadruple-speed delivery but have up to 18 discs ready for use at a time with Pioneer's newly-announced DRM-1804X. This "minichanger jukebox system" holds *three* six-disc magazines at a time, making 18 CD-ROM discs (a total capacity of 12G) available for instant use at all times. The drive uses Pioneer's Quadraspin technology delivering a 614K/s data transfer rate with a 300-ms access time. List is $2,495. ■

NEC's Triple-Speed CD-ROM Drives

Pioneer doesn't have the corner on the faster-than-double-speed market. NEC released three drives that all spin at better than triple-speed. These drives offer stand-alone (no PC needed) audio-play capability as well. The current triple-speed lineup for NEC includes the following models:

- **MultiSpin 3Xe** is a triple-speed external drive that features switch-selectable SCSI 1/SCSI 2 interfacing, utilizes caddy loading and has audio transport controls located right on its front panel. Suggested list price is $600.
- **MultiSpin 3Xi** is the internal version of the 3Xe and has all of the same features, except that it mounts in a standard 5¼" drive bay and relies on the host PC for its power. Suggested list price is $500 for this model.
- **MultiSpin 3Xp** is the personal portable model that can be powered either by its ac-operated powerpack or directly from a rechargeable Ni-Cd battery pack, which enables you to take your data—and music —with you wherever you go. As with the other 3X models, the 3Xp can play audio CDs *directly* and features audio transport controls, along with a headphone jack. Suggested list is $455.

Products Mentioned

Pioneer New Media Technologies
2265 E. 220 St.
Long Beach, CA 90810
Tel.: 310-952-2111

CIRCLE NO. 112 ON FREE INFORMATION CARD

NEC Technologies, Inc.
1255 Michael Dr.
Wood Dale, IL 60191
Tel.: 708-860-9500

CIRCLE NO. 113 ON FREE INFORMATION CARD

Industry Watch

By John Hastings

Intel has been the standard bearer for computer chips since the inception of microcomputers. It designed the CPU chips used in the original IBM PC, as well as the 286, 386, 486 and current 586-class Pentiums. The company claims to have a 686-class chip in development that may be introduced in 1996. Many experts doubt the viability of a 686 chip and feel certain we'll never see a 786 chip. Each successive generation of chip consumes more power, produces more heat and incurs dramatically greater manufacturing costs. However, performance gains aren't proportional to the manufacturing costs. Some people feel that Intel will eventually introduce a new type of chip that will incorporate the newer RISC technology now present in the IBM/Motorola PowerPC chip. If this occurs, Intel may relinquish its advantage of backward-compatibility with older computers.

Compaq shocked the industry in January when it announced that it would begin using CPU chips from Advanced Micro Devices. This will be the first time the Number 3 computer maker has used CPU chips from any source other than industry leader Intel. In addition, some people feel that Compaq will produce new models this year based on the IBM/Motorola PowerPC CPU chips.

This may be a pivotal year for Intel, as the Big Three computer makers-IBM, Apple and Compaq—gain market share and simultaneously lessen any dependence on Intel. If these trends continue, Intel could find itself marketing its chips to a diminishing number of clone makers. Its saving grace could come from the next version of Microsoft's *Windows* operating system, Version 4. The difficult gestation of this version of *Windows* will assure that it will be available for only Intel-type chips for the foreseeable future. However, this new version of *Windows* isn't expected for another year. Many people feel that most applications that use features of the new operating system won't be available until mid-1995. IBM views this as an 18-month window of opportunity, an opportunity to promote its PowerPC hardware and its OS/2 operating system.

Apple hopes to make the most of this window of opportunity, as well. It's expected to announce its new PowerMacs, based on the PowerPC chips by the time you read this. The least-expensive model is expected to be priced at less than $2,100 with 8M of RAM, 160M hard drive, keyboard and video monitor.

Apple has made no effort to keep its new generation of Macintosh computers a secret. Normally, this type of information causes buyers to postpone purchases. Most companies expect a drop in sales prior to this type of announcement. This wasn't the case with Apple. The company's recent sales have been explosive. During the last quarter of 1993, Apple shipped 40% more Macs than it did in the same quarter a year earlier. A recent survey showed that six of the top 10 best-selling desktop computers were Macintosh Quadras.

IBM recently announced that it wouldn't pursue development of its own version of the Pentium CPU chip. Instead, it's expected to announce a new version of its PowerPC chip, which will include a hardware interpreter for compatibility with 486 and Pentium software. This hardware interpreter is expected to be several times faster than software interpreters, which could lead to an interesting relationship between Apple and IBM.

Apple is expected to include a software interpreter called *SoftWindows* with its new PowerMacs. This will enable the new Macs to run *Windows* software at 486 speeds. To achieve Pentium-level performance, Apple would be forced to purchase the new chips from IBM. In return, IBM may license the Macintosh operating system from Apple and include it with its OS/2 operating system. This combination would give the two computer companies maximum performance for virtually all software in the microcomputer marketplace.

While some people feel that enormous market share may make some software and hardware companies invincible in the computer industry, history has shown the opposite to be true. The first dominant spreadsheet on microcomputers was called *VisiCalc*. It was *the* spreadsheet for pre-IBM PC micros. However, its attempt to maintain backward-compatibility and make the leap forward to the IBM PC resulted in sluggish performance. With no installed base to hamper its development and no backward-compatibility issues to deal with, Lotus *1-2-3* leapfrogged ahead of the leader. Similar situations allowed *WordPerfect* to displace *WordStar* as the top-selling word-processing program. Microsoft seemed to understand this scenario and applied it to great advantage. With the increasing popularity of *Windows*, Microsoft managed to position its word processing and spreadsheet applications, *Word* and *Excel*, ahead of the previous leaders.

Ironically, Microsoft may fall victim to similar market forces. The next version of *Windows* will incorporate radical changes as it matures from a 16-bit system to a 32-bit system. With an installed base of more than 50-million *Windows* users, backward-compatibility is a major concern, which may translate into a watered-down release. In addition, if the new version isn't nearly flawless, support problems could smother Microsoft. IBM is hoping history will repeat itself. Its 32-bit system, OS/2, may be positioned well for a takeover. It's currently experiencing record sales. While some pundits may claim that *Windows* is here to stay, many said the same thing about CP/M.

Most high-speed hard drives require an interface known as SCSI. Most-high performance networks utilize a system known as Ethernet. While these are standard on most Macintosh computers, PC versions are available as substantial extra-cost options. This may change soon. Advanced Micro Devices has introduced a new chip that can handle both functions on the computer's motherboard. The chip sells for $50.

John Hastings is the president of the American Computer Exchange Corp. The American Computer Exchange has matched buyers and sellers of used microcomputer equipment since 1988. For more information contact the American Computer Exchange Corp. by dialing 800-786-0717.

If you enjoy Amateur Radio, you'll enjoy CQ

It's a different kind of ham magazine. Fun to read, interesting from cover to cover, written so you can understand it. That's CQ. Read and enjoyed by over 90,000 people each month in 116 countries around the world.

It's more than just a magazine. It's an institution.

CQ also sponsors these thirteen world famous awards programs and contests: The CQ World Wide DX Phone and CW Contests, the CQ WAZ Award, the CQ World Wide WPX Phone and CW Contests, the CQ World Wide VHF WPX Contest, the CQ USA-CA Award, the CQ WPX Award, the CQ World Wide 160 Meter Phone and CW Contests, the CQ Five Band WAZ Award, the CQ DX Award, and the highly acclaimed CQ DX Hall of Fame. Accept the challenge, Join the fun. Read CQ.

Also available in Spanish language edition. Write for rates and details.

SUBSCRIBE TODAY!

The Radio Amateur's Journal
76 North Broadway
Hicksville, New York 11801
516-681-2922 FAX 516-681-2926

Please start my CQ subscription with the next available issue.
Enclose payment or charge information with order.
Term and Rate (check one):

	USA	VE/XE	Foreign
1 Year	☐ 24.50	☐ 27.	☐ 29.
2 Years	☐ 47.	☐ 51.	☐ 55.
3 Years	☐ 69.	☐ 75.	☐ 81.

( ) Check ( ) MasterCard ( ) VISA ( ) AMEX ( ) Discover

Name _____

Address _____

City _____ State _____ Zip _____

Card No. _____

Expires _____

Signature _____

More News

Novell, Inc. will release an application-development system in May that could revolutionize the computer industry. Known as *AppWare*, the system's most vital component is Visual AppBuilder. This component gives programmers and non-programmers the ability to create powerful applications very quickly. The resulting applications can be compiled in seconds to run on either a Macintosh or *Windows* system. Novell has stated that it will charge no royalties for distribution of these applications. Numerous companies will develop extensions to this fifth-generation development system. The list of companies includes AT&T, Bell Atlantic, Borland, Gupta and Oracle. The short development cycle this system permits could result in a deluge of powerful, inexpensive applications.

Advanced Micro Devices was victorious in March in its court case with Intel. The ruling allows AMD to continue to produce clone 486 CPU chips. This competition will force Intel to produce faster, cheaper 486 and Pentium chips in the near future. Additional competition from the IBM/Motorola PowerPC chips could put a substantial strain on Intel. The result to computer users will be cheaper high-performance systems. While they've been fairly stable for the last six months, prices of used 386 and 486 computers could fall quickly.

While rumors persist that Intel is behind schedule for its next generation 686-class CPU chip, it hopes to ward off competition by boosting the upper speeds on its existing 486 and Pentium chips. The fastest 486 chips will no longer be referred to as 486; they'll be renamed DX4. These clock-tripled chips will run at 75 MHz and 100 MHz. Intel recently announced the newest version of its Pentium CPU chips. The P54C chips can run at 90 MHz and 100 MHz, compared to previous versions running at 60 MHz and 66 MHz. The new chips aren't only faster, they're also smaller and require less power. The older chips consume 16 watts of power, making them unfeasible for small, portable computers. The new chips need 4 watts of power. This clears the way for Pentium-based notebook computers. Lower power consumption also means less heat. Many experts have feared the high temperatures of current Pentium chips could shorten the life of the chips or motherboards.

Intel has increased its production of motherboards. In fact, more than half of all Pentium computers are using Intel motherboards. This has infuriated Compaq, who makes its own motherboards. The situation has allowed Compaq's competitors to reach the marketplace in record time. This "time to market" is crucial in establishing a dominant brand. To retaliate, Compaq will purchase CPU chips from Intel's competitors and may begin selling its motherboards to other makers. One version may include the IBM/Motorola PowerPC chip. Up to the time of this writing, Intel hasn't sold any notebook motherboards. Consequently, Compaq is expected to be the first to market a DX4 notebook computer.

Dell Computer returned to the notebook computer market in March. Its new offerings are manufactured by AST. The redesigned AST Bravo notebooks are expected to be a stopgap measure. Margins in the computer industry are simply too slim for two companies to make a reasonable profit from each sale. Dell is expected to announce its own versions of a new notebook computer this summer.

When a defect is discovered in the automobile industry, a recall is issued. Owners can return their cars to the dealers from which they purchased them for free repairs. When a defect is discovered in the computer software industry, the software company issues a new release of the product. By incorporating a few new features, the problems can be masked. The new release can then generate more profits for the software company. Some would say that *Windows* 3.1 was nothing more than the repair of *Windows* 3.0. The same claim may be made that MS-DOS 6.2 simply corrected problems in MS-DOS 6.0. Many people feel that the corrected software should be distributed at no charge to the early adopters of the new technology. While short-term profits might suffer, the long-term effect would be positive. Under the current policy, many computer users

Prices For Used Computer Equipment For March 1, 1994

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change
IBM PS/2 Model 30/286 20M	$300	$475	$300	–25
IBM PS/2 Model 70 60M	400	700	550	—
IBM ThinkPad 350	1,150	1,650	1,250	–50
IBM ThinkPad 700	1,400	1,800	1,550	–150
IBM ThinkPad 720	1,800	2,100	1,900	–250
AST 386/20, 80M	450	850	600	+50
Dell 325SX, 60M	400	800	650	–25
Dell 386/20, 120M	600	900	750	+75
Gateway 386SX/20, 80M	400	850	600	+25
Gateway 386/25, 80M	500	800	700	+25
Gateway 486/33, 120M	900	1,500	1,150	—
Clone Notebook 286, 40 M	350	700	525	—
Clone Notebook 386SX, 40 M	500	900	725	+100
Clone 386/25, 80M, VGA	450	850	600	+25
Clone 386/33, 80M, VGA	550	950	725	+25
Clone 486/25, 120M, VGA	800	1,250	925	–25
Compaq SLT/286 20M	250	500	375	+25
Compaq LTE 286 40M	400	775	550	+25
Compaq Deskpro 386/20e 100M	500	800	750	+100
Compaq Contura 320 60M	400	1,000	850	–25
Macintosh Classic 40M	350	600	450	+25
Macintosh SE/30 40M	375	800	650	+50
Macintosh II 40M	400	750	500	–100
Macintosh IIcx 80M	500	800	550	+25
Macintosh IIci 80M	700	1,000	900	–25
Macintosh IIfx 80M	800	1,600	1,300	–100
PowerBook 100, 20M	525	900	700	+50
PowerBook 140, 40M	900	1,400	1,050	+50
PowerBook 170, 40M	1,200	1,700	1,375	–75
PowerBook 180, 80M	1,600	2,000	1,800	–300
LaserWriter IINT	700	1,000	900	+150
Toshiba 1200XE	300	650	500	+125
Toshiba 1900 120	1,000	1,700	1,375	+25
Toshiba 3200SX, 40M	400	800	500	–50
Toshiba 5200, 100M	850	1,250	1,125	+125
HP LaserJet II	400	850	700	+100
HP LaserJet III	375	950	600	+25
HP LaserJet III	750	1,100	1,000	+75
HP LaserJet IV	1,000	1,300	1,225	+25

Prices for Used Computer Equipment for March 29, 1994

Machine	Average Buyer's Bid	Average Seller's Ask	Close	Change
IBM PS/2 Model 30/286, 20M	$300	$475	$300	$—
IBM PS/2 Model 70, 60M	400	700	550	—
IBM ThinkPad 350	1,150	1,650	1,125	–125
IBM ThinkPad 700	1,400	1,800	1,500	–50
IBM ThinkPad 720	1,800	2,100	1950	+50
AST 386/20, 80M	450	850	575	–25
Dell 325SX, 60M	400	800	625	–25
Dell 386/20, 120M	600	900	700	–50
Gateway 386SX/20, 80M	400	850	575	–25
Gateway 386/25, 80M	500	800	675	–25
Gateway 486/33 120M	900	1.500	1,050	–100
Clone Notebook 286, 40M	350	700	525	—
Clone Notebook 386SX, 40M	500	900	800	+75
Clone 386/25, 80M, VGA	450	850	625	+25
Clone 386/33, 80M, VGA	550	950	700	–25
Clone 486/25120M, VGA	800	1,250	950	+25
Compaq SLT/286, 20M	250	500	400	+25
Compaq LTE 286, 40M	400	770	550	—
Compaq Deskpro 386/20e, 100M	500	800	675	–75
Compaq Contura 320, 60M	400	1,000	775	–75
Macintosh Classic, 40M	350	600	400	–50
Macintosh SE/30, 40M	375	800	600	–50
Macintosh II, 40M	400	750	425	–75
Macintosh IIcx, 80M	500	800	550	—
Macintosh IIci, 80M	700	1,000	825	–75
Macintosh IIfx, 80M	800	1,600	1,050	–150
PowerBook 100, 20M	525	900	650	–50
PowerBook 140, 40M	900	1,400	1,000	–50
PowerBook 170, 40M	1,200	1,700	1,300	–75
PowerBook 180, 80M	1,600	2,000	1,625	–175
LaserWriter IINT	700	1,000	800	–100
Toshiba 1200XE	300	650	525	+25
Toshiba 1900, 120M	1,000	1,700	1,250	–125
Toshiba 3200SX, 40M	400	800	525	+25
Toshiba 5200, 100M	850	1,250	1,125	+125
HP LaserJet II	400	850	700	—
HP LaserJet IIIP	375	950	575	–25
HP LaserJet III	750	1,100	900	–100
HP LaserJet IV	1,000	1,300	1,125	–100

won't purchase *Windows* 4.0 when it becomes available early next year. Many will wait for Version 4.1, expecting it to be a more-stable version. Likewise, MS-DOS 7.1 or 7.2 should sell better than MS-DOS 7.0.

A new version of MS-DOS 6 will soon be on the shelves. Version 6.21 may be the first to have fewer features than its predecessor. DoubleSpace, the utility that compresses data on disk drives, will be removed. For the first time in its 19-year history, Microsoft lost a major lawsuit. Stac Electronics claimed that DoubleSpace violated two of its patents. The jury agreed with Stac and awarded it $120-million in damages.

Why do so many companies continually upgrade to the newest computers? A recent survey has shown that more than 90% of businesses feel they recoup the cost of their PCs in one year or less. Almost half feel the cost is covered in less than six months.

Some will argue that handwriting recognition is the best method of input for computers. Others feel voice recognition is faster and more natural. At least one company has another idea. Psychic Lab Inc. has announced the IBVA, Interactive Brainwave Visual Analyzer. While wearing its headband, users may be able to control a computer through their thought processes. ■

By Tom Benford

Multimedia

Amplified speakers, a unique video-capture card, making music with your sound card and clipart on CD-ROM

There are lots of interesting multimedia items to cover in this time around, including some great amplified speakers to help your sound card sound its best, a unique video-capture card that does real-time MPEG compression at 30 frames per second (fps) with no hardware assist required for playback, some excellent products for making music with your sound card or MIDI setup and an interesting clipart package on CD-ROM. So let's jump right in.

Multimedia Speakers

The best way to get maximum performance and output from your multimedia sound card is to connect a pair of high-quality speakers or headphones to its output port. Labtec has a selection of speakers in a variety of price ranges that will let you hear it like it is. All models are magnetically shielded for video monitor, drive and disc protection, and they all come in the standard beige color that complements with PCs and Macs, except the CS-700s, which are a sleek black color.

Here's a run-down on three of the models in the Labtec lineup I've used that are representative of the product line:

The entry-level setup is the Labtec CS-150, which is priced at $39.95. This pair of amplified stereo speakers can be powered by C cells (two in each speaker enclosure) or an optional 6-volt dc adapter. Each enclosure holds an 8-ohm 3" speaker driver. These speakers produce a maximum output of 3.6 watts rms over a frequency response of 60 Hz to 14 kHz. They can also function passively (without amplification), and individual volume controls and bass-boost switches are provided. The sound quality and volume of CS-150 speakers are excellent, and the price is right as well.

Moving up to Labtec's CS-800 series at $69.95, you get an active speaker system that comes with a dc power supply and features a pair of 8-ohm 3½" speaker drivers that produce 6 watts maximum rms output over a frequency-response range of 50 Hz to 15 kHz. The "master" speaker unit holds all of the controls, which include power, bass-boost and treble-boost switches and a volume control. The additional power, larger speaker size and enhanced frequency response make this model a good choice if you have more-demanding aural requirements.

Next up is the $149.95 CS-1000 space-saving active speaker system that provides a convenient enclosure on which you can sit your PC's video monitor. The enclosure is home to a direct-firing, rolled-edge woofer system that provides excellent full bass response with dual 3" midrange/tweeters to enhance the mids and highs. Maximum output is 5 watts rms per channel, and the front-mounted conveniences consist of volume and tone controls, a power switch and a headphone jack. The CS-1000 measures 3¼" high. Its sound quality is excellent.

If you want top-of-the-line performance and sound quality, look no further than my personal favorites, Labtec's multimedia CS-1400 active speaker system, which retails for $179.95. Each of the enclosures in this system houses a 3" rolled-edge woofer, a 2" alnico tweeter and a tuned-port cabinet for enhanced sound baffling. All controls are single-sided (mounted on one speaker enclosure only) and consist of a power switch, volume control, treble/bass controls, balance control and headphone jack. A 14-volt ac/dc power adapter is included. Speaker impedance is 4 ohms. Frequency response is rated at 60 Hz to 20 kHz, with a maximum output of 15 watts rms.

Labtec CS-180 speakers deliver 4 watts of power and attach to sides of the computer monitor.

CS-1000 system puts out 5 watts, nestles under a PC's video monitor to save space.

The CD-1400 is the way to go for serious musical and multimedia applications, presentations, trade show demonstrations and anytime lots of volume with outstanding sound quality is desirable.

Other models in the Labtec lineup are detailed in Table 1.

Labtec also has a line of headphones and microphones designed specifically for multimedia use that I'll cover in a future column.

MPEG Video Card

Microsoft's *Video for Windows* and Apple's *QuickTime for Windows* have made capturing video and displaying it on a PC a standard component in multimedia productions. Thus, video is very prevalent in today's software offerings. But both *VfW* and *QTfW* have their limitations in that, while offering decent frame rates in the neighborhood of 15 to18 fps on the fastest systems, they still fall far short of the broadcast video standard of 30 fps. The reason for this is that each frame of video contains so much information it taxes the CPU to process it all and puts a strain on even the fastest drive to transfer it at such a high frame rate. The solution is to compress the video data to make it transfer faster.

While several video hardware compression/playback cards exist, they usually require that the card be present in the playback system to let you enjoy the benefits of 30-fps playback speed. Xing technology has shattered this requirement with its Xingit! MPEG Video Card. What makes the Xingit! card unique is that it does full 30-fps MPEG compression on the fly in realtime during video-capture, and its compression is so compact and efficient that it can be played back on any reasonably-fast 486 (33-MHz or quicker) machine at 30 fps in a 320 x 240 window in *Windows* without hardware assist. Xing even provides a royalty-free runtime player for distributing captured video sequences that run from DOS or *Windows*.

This full-length card requires a 16-bit slot for installation. Though best performance is obtained on a 486, this card it will also work with 386-based machines (although playback frame rate will be less than 30 fps). A single phono connector on the card's mounting bracket accommodate input from a VCR, laserdisc player or other composite video source.

The only hardware configuration required prior to installing the card is selection of a suitable base I/O address and hardware interrupt. You do this by placing jumpers on the appropriate pins of a seven-pair jumper bank, selecting the appropriate combinations and choices detailed in Table 2.

You install the card's software from *Windows*. The software-installation process is highly automated, although you'll have to make some minor configuration selections to tailor the card specifically for your system. The installation program also adds the Xingit! path to your AUTOEXEC.BAT file. This modification is required to provide proper access to the software's functions.

Once main installation is completed, you must configure the software so that it communicates with the Xingit! card. This particular step isn't required for playback, but it is essential for video capture.

The configure screen, shown in Fig. 1, provides the valid choices for base address, interrupt, memory bank and input video standard. Selections for base address and interrupt must accurately reflect the configuration of the card's jumper positions. Memory-bank selection defaults to C800 through CFFF, unless you select another 34K bank. The default will work fine, unless you have another peripheral installed in your system, such as a scanner, that may conflict with this address space. There are also specific choices reserved for systems with 14M and 15M or more of installed RAM. Again, for proper card operation during video capture, it's essential that memory selections be configured correctly.

If you're using a different memory manager than Microsoft's EMM386.EXE (for example, *QEMM*), consult its documentation for instructions on how to exclude a memory bank for use by Xingit!. If no extended memory manager (other than HIMEM.SYS) is being loaded into your PC's CONFIG.SYS file, you'll have to

CS-1400 series is Labtec's top of the line speaker system, delivering 15 watts rms with rich bass and crisp treble response.

Table 1. Labtec Speaker Systems*

Model	Price	Frequency Response	Maximum Power**	Size	Impedance
CS-180	$49.95	60 Hz to 14 kHz	4 Watts	3"	8 Ohms
	Active or passive system; has brackets to mount on sides of PC video monitor.				
CS-550	$59.95	40 Hz to 16 kHz	4 Watts	3"	8 Ohms
	Battery or dc-adapter power; treble-boost and power switches; enhanced bass-response enclosure design.				
CS-700	$69.95	95 Hz to 18 kHz	7 Watts	4"	8 Ohms
	Battery or dc-adapter power; has built-in three-band equalizer, individual volume controls; black color.				
CS-900	$129.95	50 Hz to 18 kHz	7 Watts	4"	8 ohms
	Dc adapter included, dual line inputs, bass port on cabinet, single-sided controls, treble boost and slider bass boost.				

*Not reviewed in text. **In watts rms.

manually edit your *Windows* SYSTEM.INI file to exclude the memory bank selected for use by the Xingit! card, as follows, again using C800 through CFFF:

```
[386Enh]
device=c:\utils\tape\CMSDTAPE.386
device=vhhscand.386
display=VDDTLI4.386
emmexclude=C800-CFFF
```

Xingit! is capable of accepting either American NTSC or European PAL composite-video input, the default being NTSC. Change this *only* if you're using a PAL video source outside the US. Clicking on OK locks in the choices, and selecting "Save Xingit! Preferences" makes these selections a permanent part of the Xingit! environment, unless you intentionally reconfigure it for some reason.

Xingit! uses a *Windows* bitmap driver to communicate with the PC's video hardware and quickly play back video data on a PC's video monitor. Since this Device Independent Bitmap (DIB) driver is active by default, Xingit! will work with any *Windows*-compatible video hardware. However, achieving even faster playback of video sequences is possible by disabling the DIB driver and using one of the direct video drivers supplied. Disabling the DIB and selecting a direct video driver is easily accomplished from the drop-down "video driver" item in the Xingit! Player's "view" menu and saving the selection from the preferences menu.

Here's a list of the direct video drivers currently provided with Xingit! (software Version 1.1A, as of this writing):

ATI—ATI VGA Wonder
CIR—Cirrus GD5422 and GD5424 (640 X 480/256 color)
CR8—Cirrus GD5422 and GD5424 (800 X 600/256 color)
CPQ—Compaq AVGA
JAW—Dell Jaws VGA
S3—S3 86C911/924 (256 color)
S38—S3 86C801/805 (256 color)
S3H—S3 86C801/805 (Hi Color)
TRI—Trident 8900 B/C
TSG—Tseng ET4000/Weitek 5186
V7—Video 7 HT-209D/216
WD—Western Digital WD90Cxx

If a direct video driver for your adapter doesn't appear on this list, you must use one of the following two supplied Xingit! DIB drivers:

8-BIT Windows Video DIB—the default eight-bit driver

24-BIT Windows Video DIB—available only from the menu if your *Windows* display driver is set for high-color or true-color display since your video card must be capable of these modes to access them.

When installation and configuration are done, you're ready to start using and enjoying the capabilities of MPEG-compressed video that Xingit! offers. A sample file of two killer whales leaping out of the water is provided to demonstrate the card's capabilities, and there's a musical soundtrack to accompany the video. Shown in Fig. 2 is the Player screen with the first frame of an MPEG video sequence loaded and poised for action as soon as you click on the "play" button. As you can see, the video transport controls resemble those of a VCR and conform to standard software interface layouts. Hence, there's no learning curve for using the software right away.

To do your own captures, click on the camera icon to invoke the Xingit! MPEG Recorder screen shown in Fig. 3. From this, you're able to preview the incoming video signal, select a frame rate and configure the audio recording options. Audio configuration permits playback of standard .WAV files or MPEG audio files that contain compressed data (compression is handled by the Xingit!'s on-board Analog Devices ADSP-2115 digital signal-processing chip) that reduces the amount of disk space required. You can also choose the "No Sound" selection if you wish to ignore all audio.

Xingit! uses a software decoder to send data to the PC's installed sound card on the version I reviewed (1.1A). By the time you read this, direct drivers will be available for communicating directly with most popular audio cards, making possible higher-quality sound reproduction with less processor overhead.

If you make the .WAV selection, the *Windows* configuration for your audio card is used. If you use Xingit!'s audio decoder, you can configure it to your own preferences and requirements.

Explanations for entries in the audio decoder menu shown in Fig. 4 are as follows:
• ***Quality*** determines the number of audio sub-bands decoded. Low quality decodes the seven highest-amplitude sub-bands. Medium quality decodes the eight highest-amplitude sub-bands. High quality decodes the 16 highest-amplitude sub-bands.
• ***8 Bit/16 Bit*** determines the amount of data per audio sample sent to your PC's audio driver.

In actual practice, I found the eight-bit/medium quality settings to be quite acceptable for doing video captures of non-musical segments from a VCR. The eight-bit/high quality setting is much better for doing captures in which music is present, while using only half the disk space required for 16-bit/high quality. Although the latter is, indeed, better sounding, most casual users won't notice much of a difference, if any.

A sound-coupling feature is also provided in Xingit!'s software because some audio cards accept data non-standard sampling rates (for example, a card that promises a sampling rate of 44.1 kHz might accept only 44 kHz in reality). Such a discrepancy can cause problems when very-long video sequences are played with audio accompaniment, and "lip sync" may be lost. The sound-coupling feature can be activated if the video and audio are unsynchronized to correct the problem, in most cases. When activated, the sound-coupling feature detects the rate at which the audio

Table 2. Jumper-Selection Guide For Xingit! Video Card

Base I/O Address	Jumper 5	Jumper 6
0x340	Short	Short
0x320	Open	Short
0x300	Short	Open
0x280	Open	Open

Interrupt	Cap On
IRQ11	Jumper 1
IRQ10	Jumper 2
IRQ3	Jumper 3
IRQ5	Jumper 4

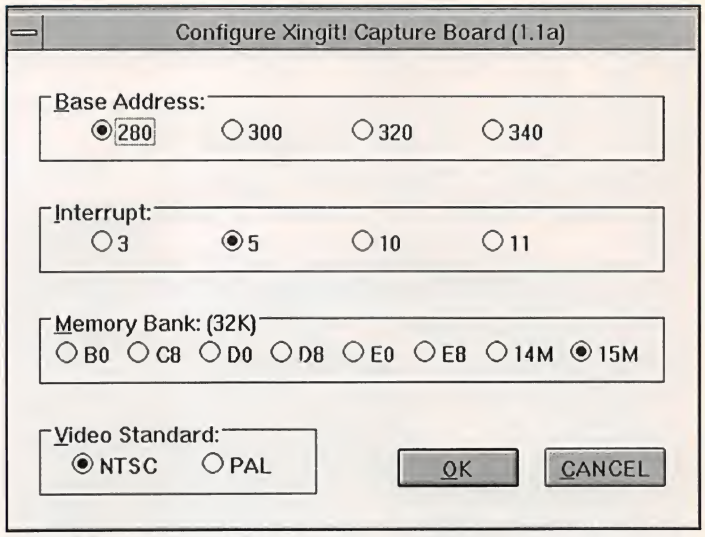


Fig. 1. Xingit!'s configuration screen details available base addresses, IRQs, memory banks and video input standard.

card is accepting new data and uses this as a base for calculating sampling rate.

Keep in mind that activating the sound-coupling feature can adversely affect synchronization of audio and video data if your audio card has a large on-board buffer. For example, if the audio card buffers an initial data transfer of 64K, Xingit! will calculate an inappropriate sampling rate based on this value. I experienced this with my Antex Z-1 audio card, which has 128K of on-board buffering. Since there was no problem with the .WAV audio format, this is what I used. Future software versions will remedy these problems, according to Xingit! sources.

You can also save individual video frames as *Windows* .BMP (bitmap) files from the File menu for any use you may have for them, such as wallpaper or backgrounds.

To sum up the playback performance and quality of the video captures I've done using the Xingit! card, "amazing" is

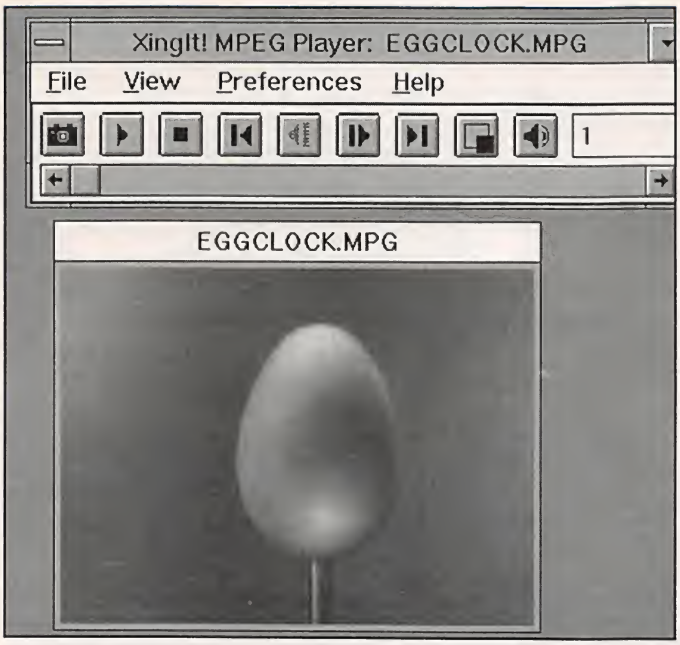
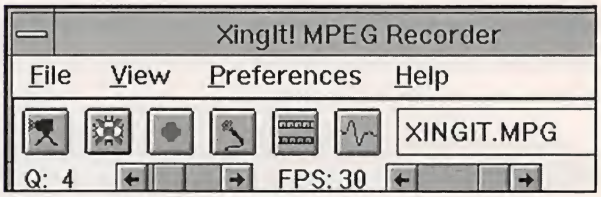


Fig. 2. Xingit!'s Player screen with an MPEG video sequence loaded and ready for playback. The player doesn't require hardware assist on 486-based systems for full 30-fps playback with synchronized audio. The player is a free runtime program that can be freely distributed and works under *Windows* or directly from a DOS prompt.

Fig. 3. Xingit!'s Recorder screen permits you to preview the incoming video and select frame rates and audio format options.



a good word to use. The full 30-fps rate produces smoothness of motion that far surpasses anything I've seen in *Video for Windows* and *QuickTime for Windows* (or *QuickTime* on a Mac, for that matter). Seeing is believing, however, and you can see for yourself by calling the Xingit! BBS by dialing 1-805-473-2680 and downloading the player and sample MPEG video files. Since you don't need the card to play back these files, this is an excellent way to get a first-hand look at what Xingit!'s MPEG video can do for only the price of a phone call.

MIDI/Music Corner

Band-In-A-Box Pro for *Windows* ($88) from PG Music is one of the my favorite and most-useful musical-composition programs for "roughing out" a tune or just creating a background to practice playing along with. PG has just released its new *Styles Disk #4* for *Band-In-A-Box* that adds 34 excellent new styles to the already-impressive styles library available for the program. Included are nine new jazz styles, six new country styles, seven new pop styles, four "old pop" styles and six new ethnic/miscellaneous styles. With this new disk, you can crank out automated accompaniments that sound like the studio musicians who might have done sessions with Fats Waller, Chet Atkins, Larry Carlton, The Drifters, The Supremes and Mozart. There are even two Klezmer (Israeli) styles!

Most of the 34 styles on this disk utilize five instruments at a time (bass, drums, piano, guitar and strings), and four of the included styles are updated versions of the three-instrument versions previously released on *Styles Disk #2*. If you're a *Band-In-A-Box* user, this $29 styles disk is absolutely indispensable.

Two other new products from PG Music are *The Jazz Pianist* ($49), an excellent tutorial program that makes it easy (relatively speaking) to learn to be a great jazz pianist. This program is a compilation of 60 jazz standards recorded by top jazz pianists in a wide variety of styles. An on-screen piano keyboard shows you exactly what the pianist is playing, and you can slow down any piece to step through it chord-by-chord to learn the music note-for-note. All of the songs are provided as standard MIDI files you can load into other software that accepts this file format. There are also a music trivia and "guess the song" game, program notes, biographies, a music dictionary and much more on the disk. The disk plays back using either a PC sound card or a MIDI system. If you're into jazz piano, check out *The Jazz Pianist*.

The Jazz Guitarist ($49), another PG Music title, is to string-pickers what *The Jazz Pianist* is to ivory-ticklers. As with the other program, *The Jazz Guitarist* is a music program that contains a huge collection of more than 60 jazz standards played on a MIDI guitar by top jazz/studio guitarist Oliver Gannon. An on-screen guitar fretboard shows exactly what guitar notes are being played, and the pieces can be played in realtime or can be stepped through chord-by-chord. Special built-in support for Roland GS and General MIDI sound modules permits you to use the mixer to change volume, patch, panning, reverb, chorus and tuning. Jazz trivia and guess-the-song games are included, as are biographies of the music and jazz-guitarists. If you want to learn how to play jazz guitar, *The Jazz Guitarist* is the next best thing to having a live teacher and personalized instruction. It's much less expensive and infinitely more patient, too!

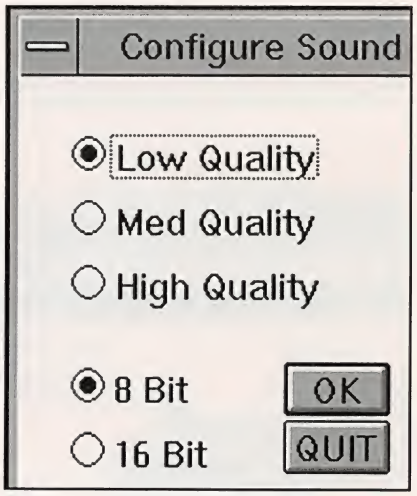


Fig. 4. In Xingit!'s sound-configuration screen, options are available only if the MPEG decoder format is selected. Using .WAV format inherits the setting already selected for your sound card from *Windows*.

The Solo Assimilator ($29.95) from Lil' Johnny Enterprises is another tutorial product that works both with *Band-In-A-Box* and other software sequencers that can accept standard MIDI files. It's partic-

Fig. 5. Egypt's pyramids are just one of the more-than-6,000 color clipart images on the *Corel' Gallery* CD-ROM. This disc has more than 10,000 images total. Images are easily previewed and exported to virtually any *Windows* application that can accept graphics in a wide variety of formats.

ularly useful for guitarists, but virtually any musician who is looking to expand his or her musical vocabulary of blues phrases will benefit from this package.

This program contains 11 solos, drawn from a wide range of songs by accomplished blues guitarists, and they're based on licensed songs performed by B.B. King, Buddy Guy, ZZ Top, Albert Collins, Lonny Brooks, Jimmy Thackery, Son Seals, Hound Dog Taylor, Fenton Robinson, Chris Cain and Muddy Waters. Each solo has been played in realtime with a MIDI guitar and is generally a chorus long, ranging in length from eight to 18 bars. Additionally, each solo is divided into a number of phrases that can be looped in the software to provide a total of 59 phrases. All solos are accompanied by bass and drums, along with either a low-volume organ or a rhythm guitar to suggest the background style that accompanied the originals. Blues styles include shuffles, slow blues, minor blues and jump blues/bebop.

The Solo Assimilator helps learning blues phrases faster because you can hear the phrase in context to the background progression, style and other phrases in the composition. Additionally, you can play along with the phrase at any speed in any key and for as long as you want.

The diskette is accompanied by a 40-page booklet that includes professionally-prepared sheet music and tablature that clearly shows such guitar nuances as bends and hammer-ons that aren't presently well-supported by MIDI for guitar (target notes are provided for bends). Other information in the manual includes loading instructions along with file names, MIDI channels used, recommended volumes and patch numbers. A discography references you to the actual recording from which a MIDI solo was prepared.

Products like *The Solo Assimilator* and the two programs from PG music covered here demonstrate what a terrific music teaching tool the computer can be with the right software. For less than $30, *The Solo Assimilator* is one of the best MIDI software values available. It's well worth the price, even if you're not looking to learn blues guitar, just to get the collection of 11 blues solos to listen to.

On The Optical Front

Corel has released it's new *Corel Gallery* CD-ROM ($59) that contains 10,000 professionally-designed clipart images, of which more than 6,000 are in color. The *Gallery* is a subset of the clipart contained on *Corel Draw* 4.0. A previewer/exporter utility is provided for *Windows* users. More than 50 categories provide a wide range of topics, and some of the many included offerings are images of celebrities, business graphics, transportation, food, maps, musical instruments, landmarks, and lots more.

The included access utility enables you to easily browse through the categories and preview each image. You can drag and drop the images into any OLE-2-enabled application. Some of the many packages that can utilize the clipart images include Microsoft *Word*, Lotus *Ami-Pro, WordPerfect, Microsoft Publisher, Ventura Publisher*, Aldus *PageMaker*, MS *PowerPoint*, Lotus *Freelance* and *Harvard Graphics*, to name a few.

Even if you don't use computer graphics software, you can still add flair to your communications with the imagery contained in *Corel Gallery*. The quality and variety of the images contained on this disc make it well worth the purchase price and an affordable companion for your word processing, presentation or desktop publishing software. ■

Products Reviewed

Labtec PC Multimedia Speaker Systems
Labtec Enterprises, Inc.
11010 NE 37 Cir., Unit 110
Vancouver, WA 98682
Tel.: 206-896-2000

CIRCLE NO. 165 ON FREE INFORMATION CARD

Xingit! MPEG Video Capture Card
Xing Technology Corp.
1540 W. Branch St.
Arroyo Grande, CA 93420-1818
Tel.: 800-2-XINGIT;
BBS: 805-473-2680

CIRCLE NO. 166 ON FREE INFORMATION CARD

Band-In-A-Box Pro, The Jazz Pianist, The Jazz Guitarist
PG Music Inc.
266 Elmwood Ave., Ste. 111
Buffalo, NY 14222
Tel.: 800-268-6272

CIRCLE NO. 167 ON FREE INFORMATION CARD

The Solo Assimilator
Lil' Johnny Enterprises
20 N. Allen Ave.
Richmond, VA 23220
Tel.: 804-259-5917

CIRCLE NO. 168 ON FREE INFORMATION CARD

Corel Gallery
Corel Corp.
The Corel Bldg.
1600 Carling Ave.
Ottawa, Ontario, Canada K1Z 8R7
Tel.: 613-728-3733

CIRCLE NO. 169 ON FREE INFORMATION CARD

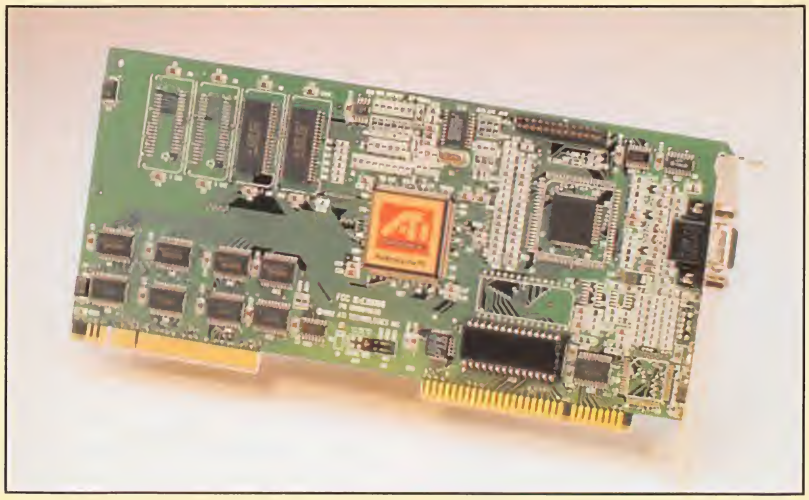
By Ted Needleman

Microcomputer Musings

ATI Graphics Wonder Video Card; Epson ActionPrinter 3260; Multimedia CD-ROM Utilities

It seems that lately, whenever I'm using a PC, it has something to do with graphics, digital imaging or multimedia. Even the word processor I'm using, Microsoft's *Word for Windows* 6.0, has extensive clipart and embedded-object capability. Want to put the sound of cheering into a document? Just click on the "Insert" command, choose "Object" and then one of the sound selections (these depend on what type of hardware and software you have). You can use the *Windows* sounds (from the Control Panel) to give a "bing" or other similar attention-getting sound. Mind you, this comment about everything turning graphical/digital/multimedia, isn't a complaint or a lament. I like playing with PC applications, and they've gotten to be ever-more fun lately, thanks in large part to graphics, sound and multimedia. Even when I don't get much "real" work done, deep down, I know that the hours I spend looking at all of the goodies I report on in this column will pay off in the real world. They always have in the past!

I devote this column to some of the many products out there that are designed to enhance your computing. I lead off with a moderately priced 16-million-color video card for *Windows* and DOS from ATI, then tell you about a new low-cost Epson dot-matrix printer that can be economically upgraded for color printing and finish up with a really worthwhile multimedia CD-ROM product from Corel.



ATI Technologies' Graphics Wonder offers 16-million colors in a loca-bus (shown) or standard ISA video card for just $199.

ATI Graphics Wonder

With all of the time I'm spending looking at *Windows* and multimedia applications, I finally decided that it made sense to upgrade the video on my usual 486DX2/66 testbed PC from plain-vanilla VGA to something that can handle 24-bit color and was a bit faster. As a reviewer, I can usually get a good—even great—deal on most things having to do with computers. So it wouldn't be a big problem to upgrade to one of the newest $500 2M video-display cards. But in thinking about things, it didn't really make a lot of sense to do so. Not too many of you will be rushing out to invest in the cost of an expensive card to upgrade your video and another $500 to $750 for a new video monitor that's good enough to display the enhanced output from a super display card. And it doesn't make a whole lot of sense for me to look at software that a lot of you simply won't be able to use effectively because your hardware setup doesn't stretch the limits of performance.

The newest multimedia and digital-imaging packages require more capability than many "standard" VGA cards can provide. At least they do if you really want to get the most out of them. This doesn't mean you need 1,024 x 768 resolution, but super-VGA resolution is fast becoming a requirement. Of course, exactly what "super-VGA" actually means seems to be up for grabs, depending on who's doing the talking. For a while, it meant 800 x 600. More frequently nowadays, it seems to refer to standard 640 x 480 VGA resolution with at least 256 colors. I'll use this particular definition, at least for a while.

Displays that have 256 colors look really nice, and almost any VGA display that's been made in the last year or so can do a halfway decent job in showing them off. I wanted something a bit better than this. I didn't have a problem with 640 x 480 resolution (it actually looks pretty good to me), but I wanted 24-bit color. Using 24 bits of information per pixel yields the capability of displaying up to 16.7-million colors simultaneously. With this many colors at the PC's disposal, you frequently achieve "photo-realistic" images, with displays that look closer to photographs than they do to computer screens!

Adding 24-bit color to a PC is neither difficult nor

Epson's ActionPrinter is a $299 24-pin black-and-white dot-matrix printer that upgrades to seven-color printing for just $49.

expensive. There are lots of cards out there to do this. The one I tried was one of the newest, the Graphics Wonder from ATI Technologies. ATI developed the Mach32 *Windows* accelerator chip and markets the Graphics Pro line of high-performance video cards. Having tested a number of these "Pro" cards in high-end 486DX2/66 and Pentium systems, I find that they really do "fly." The Graphics Wonder is slightly lower in both performance and price than the ATI Pro cards.

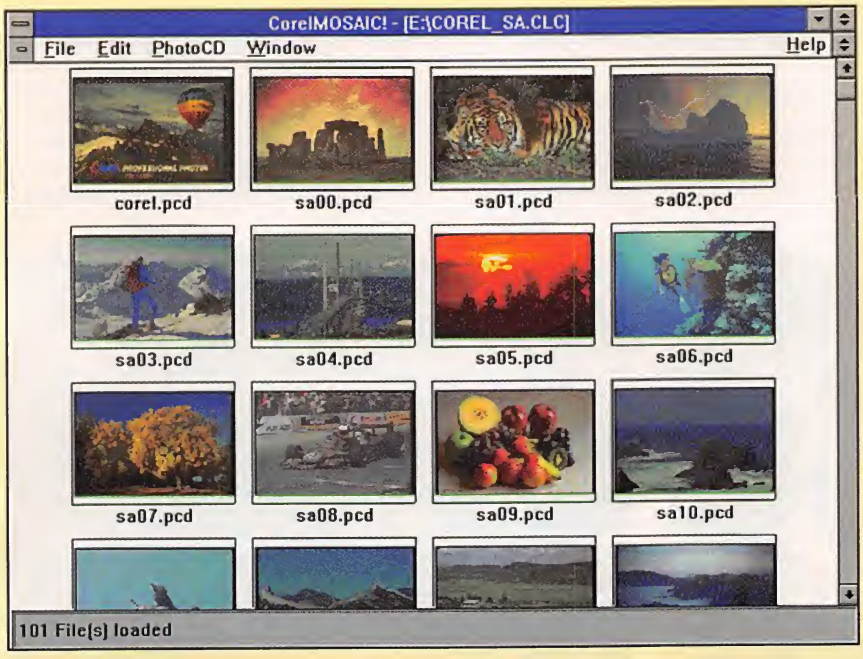
With a list price of $199 (and a street price of less than $140), the ATI card offers 24-bit color (16.7-million colors) at 640 X 480 resolution and 1M of video RAM and really speeds up graphics under both *Windows* and DOS. ATI quotes a number of graphics benchmarks to prove the point, but I've always been more than a little skeptical of benchmarks, especially for purposes like this. If you can't visually tell the difference between one graphics card and another, it probably isn't worth the money and effort to make the change.

At higher resolutions, you trade off resolution for the number of colors that can be simultaneously displayed. At 800 X 600, the number of colors drops to 256, while at 1,280 X 1,024 you're down to 16 colors. With 75-Hz refresh rates, you get a very flicker-free display.

The ATI Graphics Wonder comes in two flavors —ISA for older systems and VESA VLB for newer high-performance systems that offer a VESA local-bus slot. Since my 486DX2 has just such a slot, I installed the VESA version. Both versions operate pretty much the same and have the same resolution and color display capabilities, but because of the nature of the beast, the local-bus version is somewhat faster in many cases. If you have one of the new PCI local-bus systems, you'll either have to settle for the ISA version or go for the Ultra Pro card, which is available in PCI format. But then, if you have a PCI machine, you probably already have a pretty high-performance video subsystem installed.

Physically installing the ATI Graphics Wonder card is as easy as popping it into the proper slot and running the Install software that accompanies the card. The VESA version must go into a VESA slot because it can't be used in a standard ISA slot. The installation software asks slightly different questions, depending on the model of the card (VESA or ISA). The only question of real concern is the type of monitor you're using. The ATI card directly supports about a dozen NEC, ALR and IBM video-monitor models. With other monitors, you'll have to set resolution, frequency and refresh rate for your particular one. When you've finished responding to the questions, the software lets you test the card. If it checks out okay, you're all done.

I'm really starting to like ATI's stuff. The Graphics Wonder card works just great, and it passes my "visual" benchmark, running noticeably faster than the other card I had in the system. But what I like most is now having the capability of displaying 24-bit color. The difference on PhotoCD images is like night and day, to say the least!



Corel Mosaic lets you view, search for and manage your graphics files, collecting them into "libraries" of grouped images.

In Search of Cheaper Color

While I'm on the subject of color, let me discuss for a moment the newest addition to our family of color printers—Epson's ActionPrinter 3260. With three PCs shared among my four kids, there's fierce competition regarding who gets to use the various color printers that come in for review. So far, the favorite still seems to be the Star SJ-144 heat-transfer printer. But even though Star has cut the ribbon price in half since I first reviewed it, this printer

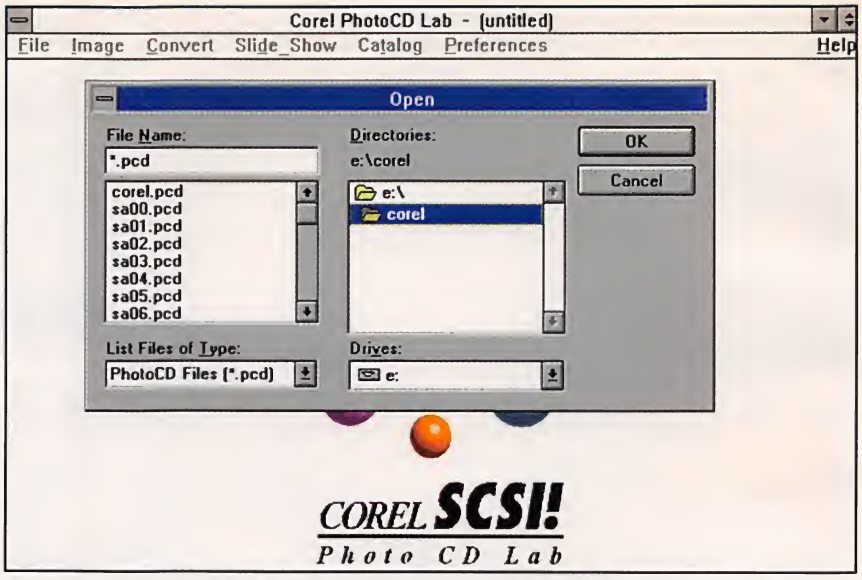
still has a fairly high per-page cost for color output, especially when compared with a dot-matrix unit like the Epson LQ-860 we had for a while.

When Epson announced the new 3260, I jumped at the chance to review it. This is the newest entry in Epson's ActionPrinter line. These are low-cost laser and dot-matrix units. Looking almost exactly like an ink-jet printer and using standard cut-sheet paper, the ActionPrinter 3260 is a 24-pin monochrome printer that lists at $299. An optional $49 upgrade kit converts the printer to let you use a four-color ribbon. This scheme doesn't yield the type of quality output a thermal dye-transfer or heat-fusion printer like the Fargo Primera or Star SJ-144 can produce. It also doesn't measure up to the quality of an ink-jet unit like HP's DeskJet 550C. At the same time, the cost per page of the resulting seven-color output (which is about as good as it gets with a four-color dot-matrix ribbon) is measured in pennies, not in substantial fractions of a dollar.

Outside of removing shipping restraints, literally no setup is required of this printer, except for plugging in power and parallel cables. Upgrading the ActionPrinter to color capability requires a bit more work, but not much. First you install a small lifter motor on the ribbon carriage. This just clips onto the carriage and has a short cable that plugs into a nearby jack. The four-color ribbon mounts on a special metal bracket that, in turn, mounts on the ribbon carriage. This takes an additional 45 seconds or so to accomplish. In fact, installing the new printer driver in the *Windows* Control Panel takes about as long as performing the physical color upgrade.

Epson rates both its black and color ribbons in terms of millions or hundreds of thousands of characters. The real test is just how faded you're willing to let printouts become before you replace the ribbon.

Let's face it. No dot-matrix printer, even a 24-pin unit such as this one with 360 x 360 resolution, is going to produce the kind of knock-you-off-your-feet color you need in the business world. But for a quick splash of color, or for your kids to add color to their projects and reports for school, the ActionPrinter 3260 fits the bill just fine. It's a little noisier than I'm used to, being that it's been a while since a dot-matrix printer has been in my house, but it's small, a lightweight 10 pounds and carries a street price that's well under an affordable $300. Best of all, color output is cheap enough that you won't always be yelling at the kids to print out in black and save color printing for when it's absolutely necessary.

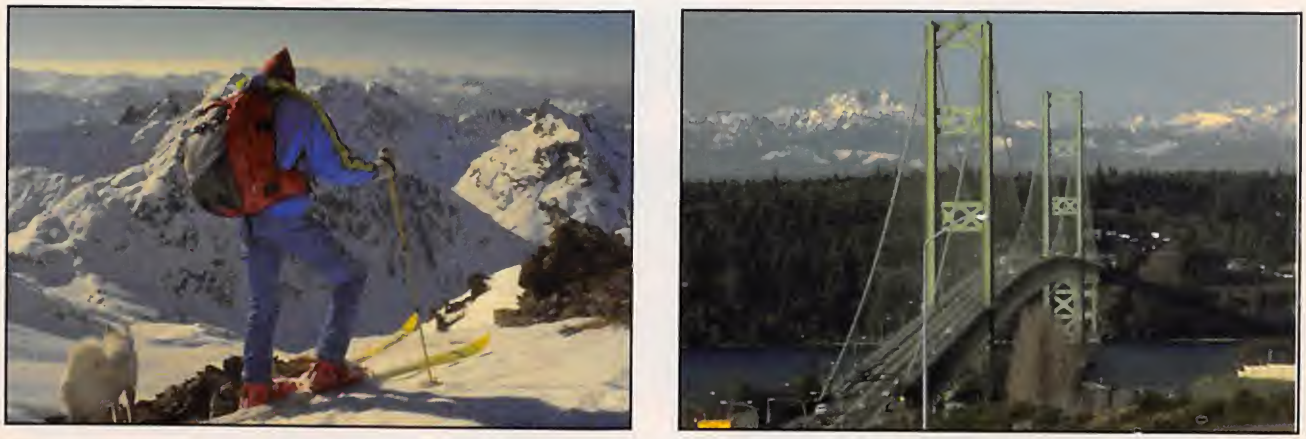


PhotoCD images combined with Corel's *PhotoCD Lab* software and the Corel SCSI drivers and caching software for CD-ROM drives make up the first two components in Corel's *CD Power Pak*. *PhotoCD Lab* lets you convert PhotoCD images into .TIF, .PCX, BMP or .EPS files, or use them in a slide show.

Power to the CD

I keep getting asked what the major difference is between multimedia upgrade kits. From the dozen or so kits I've looked at during the last 18 months or so, the greatest differences seem to be in two areas. One is the sound card. Most upgrades right now give you a fair-quality 16-bit FM-synthesis type card. A few of the more upscale vendors are starting to package wave-table cards instead. The CD-ROM drives themselves are all good in quality, ranging from the slightly less-expensive Mitsumi to the upscale NEC.

The other area of difference in multimedia upgrade packages is in the software that comes with them. There are usually a bunch of applications like an encyclopedia, and often a heavy-duty game like *The 7th Quest*. Finally, there are almost always utilities that range from home-grown (and often looking it) to OEM packages from Voyetra, Midisoft or Anamotion. Sometimes, these CD-ROM utilities are okay, sometimes they're not. If you're unhappy



Two of the eye-popping PhotoCD images Corel supplies in its $99 *CD Power Pak*.

with what you have, you may want to look at one or both of the CD-ROM utilities that follow. And even if you're not unhappy, either or both provide some testing and configuration options beyond what's included with many of the "package" deals you see on the market.

MPC Wizard from Aris Software has to be one of the best buys in the software world. I make this statement based as much on price as on content. With an suggested retail price of less than $20 and a street price that's generally about $15, even if you never use more than a tenth of what's on this CD-ROM, it would be difficult to figure you got "taken." Aris bills it as a diagnostic utility, but while it can test your CD-ROM drive and sound card, it reports performance figures rather than what's wrong if there's a problem. In this sense, it's somewhat limited as far as how much help it will be when you're troubleshooting, though it does offer some helpful suggestions on solutions to common problems.

Along with these tests, *MPC Wizard* has some stunning images you can export to use in your multimedia creations or just display on your screen as a super screen show (complete with music). These samples are from the various photo collections Aris offers on other CD-ROMs. They encompass space scenes, flowers, old planes and underwater photos and look good in super-VGA (640 x 480 x 256-color) resolution. I really didn't appreciate just how good they are until I performed the ATI Graphic Wonder video-card upgrade. Wow! I feel like I did when I got my first pair of glasses. So this is what the world looks like!

You can find *MPC Wizard* in just about any mail-order catalog or software store. Go ahead, spend the 15 bucks. If you use only one photo, it's worth the money!

A bit more upscale is the new *CD Power Pak* package from Corel. This far sighted company was into CD-ROM pretty early, with *CorelDRAW* available on CD-ROM from Version 3.0. Corel is also very much into PhotoCD, the image-storing standard developed by Eastman Kodak, and offers dozens of CD-ROMs crammed with PhotoCD collections. Each CD-ROM offers at least 100 images on it, with each disc built around a central theme (like photos of pets, or planes, or boats, or flowers...). When you buy a disc, you also buy the right to use the images. It's the old stock photo art carried into the technological age, and it works just great!

Corel has leveraged this investment in PhotoCD with its expertise in SCSI technology. Along with graphics, Corel was also one of the first companies to develop a larger driver set for SCSI devices and, to this day, remains one of the major players in this market. Corel SCSI, a separate product, has device drivers for CD-ROM units, rewritable optical disks, scanners and just about any other SCSI device you can think of.

PhotoCD images combined with Corel's *PhotoCD Lab* software and the Corel SCSI drivers and caching software for CD-ROM drives make up the first two components in Corel's *CD Power Pak*. *PhotoCD Lab* lets you convert PhotoCD images (Corel supplies a sample of 100 images) into .TIF, .PCX, BMP or .EPS files, or use them in a slide show. The Corel drivers add functionality beyond most vendor-supplied CD-ROM device drivers and, depending on your setup, let you add a software cache to speed up CD-ROM access.

Along with the above, Corel also includes a very nice CD-Audio player utility and .WAV file editor from Voyetra (depending on the software bundle you received with your CD-ROM, you may already have one or both of these programs). From the popular *CorelDRAW* package, the vendor has added Corel Mosaic, which lets you view, search for and manage your graphics files, collecting them into "libraries" of grouped images. Finally, there's a Wallpaper Flipper that swaps around *Windows* wallpaper images so that a different one appears each time you restart *Windows*, and a System Browser that gives you information about your system, the operating system and *Windows*. Want to know about Global Help usage in *Windows*? No? Well, maybe you'll get more use out of the many eight- and 16-bit audio samples included on this CD-ROM.

CD Power Pak is provided with some of the software on a floppy disk, as well as on two CD-ROMs, with the same software, the 100 PhotoCD images, screensaver software and 150 sound files. Finally, topping off everything are Koss earphones. Now, you know you're not getting $200 headphones in the box, but they're pretty nice nonetheless. Considering the list price for this package is just $99, and I've seen it in mail-order catalogs listed for less than $70, I don't see how you can go wrong by buying this package. If you have one of the slightly older upgrade systems, many of which didn't bother to include the really nice *Windows*-based CD utilities, you'll love the CD-Audio player and .WAV file editor.

Products Mentioned

MPC Wizard, $19.95
Aris Multimedia Entertainment
310 Washington Blvd.
Marina Del Ray, CA 90292
Tel.: 310-821-0234

CIRCLE NO. 170 ON FREE INFORMATION CARD

Graphics Wonder, $199
ATI Technologies Inc.
33 Commerce Valley Dr. E.
Thornhill, Ontario, Canada L3T 7N6
Tel.: 905-882-2600

CIRCLE NO. 171 ON FREE INFORMATION CARD

CD-Power Pak $99
Corel Corp.
1600 Carling Ave.
Ottawa, Ontario, Canada K1Z 8R7
Tel.: 613-728-8200

CIRCLE NO. 172 ON FREE INFORMATION CARD

ActionPrinter 3260, $299; $49 Color Upgrade
Epson America, Inc.
20770 Madrona Ave.
Torrance, CA 90509-2842
Tel.: 800-GO-EPSON

CIRCLE NO. 173 ON FREE INFORMATION CARD

By Joe Desposito

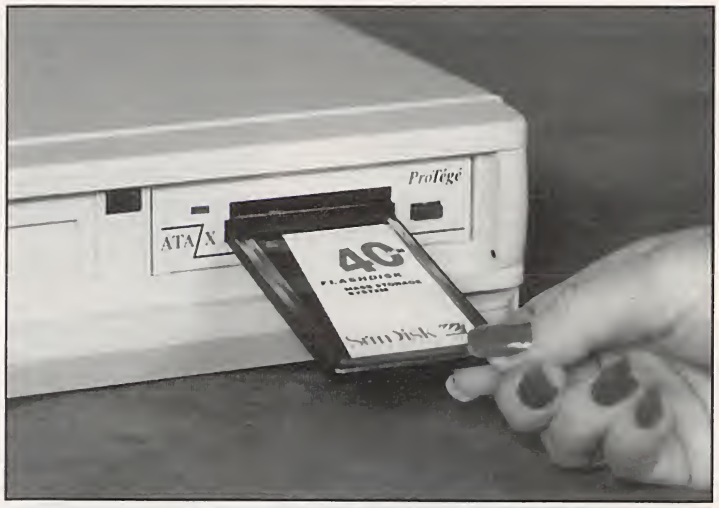
Computing On the Go

Moving Data From Subnotebook to Desktop is No Easy Task

A subnotebook computer appeals to me for two main reasons: size and weight. In my last column, I reviewed two models in this class, the Hewlett-Packard Omnibook 300 and Epson ActionNote 4000. I concluded that the Epson had more utility for me for the simple reason that it comes with a 3½" external floppy drive. This begs the question: Doesn't an external floppy lessen a subnotebook computer's appeal by adding weight to the package? Abso-lutely! An external floppy is not the *best* solution for this and other reasons.

In the case of the Epson, the external floppy drive uses the parallel port for data transfer. Anytime you want to switch between the external floppy and a printer, you have to power down to remove the floppy and then power up to change CMOS settings. Only after this is done do you regain use of the parallel port for printing. Clearly, the external floppy drive is a headache. But is there a better solution?

In my opinion, the best solution is a PCMCIA drive on the desktop. A PCMCIA drive makes it convenient to move files from the subnotebook to the desktop. All you need is a PCMCIA SRAM or FLASH disk card. You pull the card out of the subnotebook and plug it into the desktop PC. Nothing could be easier. So when I received a call from the ProTégé Corp. about its new PCMCIA drive, the ATA/X PCMCIA-ATA Data Exchange Device, I told the representative to send it to me right away. When the package arrived, I examined the drive, which has a 3½" form factor, examined the accompanying card and thought that installation would be a snap. It should have been, too, but somehow problems always seem to arise. It should be noted, though, that none of the problems was caused by the ProTégé drive.



ProTégé's new ATA/X PCMCIA-ATA Data Exchange Device.

My problems started with my computer system, an ALR PowerFlex that I haven't opened for about nine months. Since the system has a baby AT footprint, adding a new drive is an adventure. To fit the controller for the new drive into my system, I had to move two other cards around. I did this to solve problems caused by the width of one of the cards. To mount the ATA/X drive in a bay, I first had to remove a vertically mounted 3½" drive. Then I decided it would be best to move my 5¼" floppy to a the lower of two 5¼" bays. The ATA/X drive didn't include a 5¼" mounting bracket, which I needed.

When I went looking for a bracket, I realized I didn't have one on hand. A bracket costs only a few bucks, but I had to wait until the following day to purchase it. Eventually, I installed the drive in the bay and connected it to the controller. This was easy. Connecting it to the power supply should have been just as easy, but the ATA/X drive is only about two-thirds as long as a 5¼" floppy drive. Consequently, the connector from the power supply didn't reach to it. I went looking for an extension, but couldn't find one. After taking a closer look at the cabling, I decided to snip the plastic tie that held the power connectors together. This solved the problem, and I was able to complete the installation.

I turned on the computer and waited. Not much happened. The hard drive whirred and stopped, but the screen was blank. I poked around a bit and finally traced the problem to the video card. I guess I caused a problem with the video card when I moved the other cards around. I pulled the video card and decided to clean the gold contacts. Years ago, I cleaned gold contacts with a pen eraser, but this item seems to have disappeared from store shelves. A techno whiz in the office, Rich Feustel, offered me his Dremel Moto Tool, with a soft wire brush attached to the tip. After trying the tool out on an old card, I was satisfied that it would do the job. Using the slowest speed, I ran the spinning brush up and down along video card's gold contacts. After I finished cleaning the contacts, I sprayed the card and the expansion slot with compressed air. When I turned on my system, the video came back to life.

One 3½" driver disk is included with the ATA/X drive. An install program sets up your system to use the drive. In my case, the software set up the ATA/X as the D: drive. Testing the drive, however, presented a small problem: I didn't have a PCMCIA memo-

ry card. The one I had been using was a Sundisk 1.8M card that was on loan from Tandy for the Zoomer evaluation published here some months back. When I sent the back Zoomer, I also sent back the card. I scratched my head, looked around the office, and spotted the HP Omnibook. The model I have on loan has two PCMCIA memory cards. I checked the capacity and contents of one of the cards with the *Windows* File Manager, and then took it out of the system.

The card I took out is a 10M Sundisk unit. When I checked the capacity, it showed about 20M of storage space. This meant, of course, that the capacity of the card had been doubled with compression software. I put the card into the Epson notebook and it showed just 550K available out of 10M. Obviously, the Epson wasn't recognizing the compressed area of the disk. I then put the card in the ATA/X drive on my desktop system. I was happy to see that the system recognized the drive and the card. But, as with the Epson PC, DOS recognized only the uncompressed 550K. I should have stopped here and given the drive a clean bill of health. It's easy to install, it works, etc. But a larger problem loomed.

I could have reformatted the Sundisk memory card, of course, and settled for 10M of capacity. But you know as well as I do that these memory cards are very expensive right now, and it's rather difficult to resist the temptation to double their capacity. After I thought about it for awhile, it seemed clear to me that these desktop drives have to read both compressed and uncompressed disks. This capability, however, lies not with the drive, but with DOS itself.

I'm embarrassed to state that up to this point I've been working successfully with DOS 5.0; my copy of the MS-DOS 6.2 upgrade has been laying unused on a shelf. As you probably know, MS-DOS 5.0 doesn't include DoubleSpace. There has been so much negative press about DoubleSpace, that I didn't even want to bother with it. But now I wanted to know something about it.

I opened the MS-DOS 6.2 manual and tried to figure out if I could invoke DoubleSpace solely for the purpose of reading from and writing to the ATA/X drive. The documentation isn't clear on this subject. To find out for sure, I upgraded my system from MS-DOS 5.0 to 6.2. I was hoping to avoid compressing the hard disk on my system.

A little aside is in order here. My desktop computer is connected to a Novell network. After installing MS-DOS 6.2, I tried to connect to the network, but got an error message that informed me that the NETX driver I was using worked with only DOS Versions 3.0 through 5.0. I had to stop what I was doing and track down the latest version of the driver. Luckily, Rich had it on hand.

Untimited Systems' KONEXX Koupler computer telephone interface solves a bevy of portable PC communications problems.

Now it was time to find out if DoubleSpace would recognize the ATA/X drive. After invoking the setup menu and playing around a bit, I realized that DoubleSpace would do nothing for me unless I first let it compress my C: drive. I took a deep breath and decided to do this. A few moments later, I was reading a message telling me that my hard drive had errors. I needed to run DOS ScanDisk first. I did this and got my disk inspected and cleansed of all errors. I invoked DoubleSpace once more, and was informed that the compression procedure would take about an hour and 45 minutes. Exasperated, I hit Enter and put the wheels of compression in motion. An hour and 20 minutes later, the disk was compressed. I now had 225M of free space on my 210M drive instead of 65M. This will be a nice bonus if there are no adverse side effects.

With everything now in order, I ran DoubleSpace and tried to figure out how to get it to recognize the ATA/X drive. I browsed around and finally read a Help file. It said that nothing more needed to be done; DoubleSpace would recognize the drive automatically. So I popped the PCMCIA card in the ATA/X drive. I typed DIR, pressed Enter and, sure enough, all the files were there, as was 18M of free space.

Before completing this odyssey, I thought of one more thing to try. Could I still access the 550K of uncompressed space on the Sundisk card? I ran DoubleSpace again and unmounted the ATA/X drive. This didn't help, since DoubleSpace mounted the drive again automatically. Then I remembered from the Help file that this feature can be disabled. I tried the DoubleSpace Tools menu. It had a menu selection called Options, which I selected. I found what I was looking for: a check box for "Enable Automounting." I removed the X and exited DoubleSpace. You must reboot the computer after making this change, which I did and then unmounted the ATA/X drive. Now I could access the uncompressed area of the Sundisk. All my questions were answered.

If you install the ATA/X drive in your PC and use it with an uncompressed memory card, you shouldn't have any problems, except those you encounter during installation. If you expect to use a compressed memory card in the drive, you must upgrade to DOS 6.2 (if you haven't done so already) and compress your hard disk. Then you'll be able to work with either compressed or uncompressed memory cards.

Although the ATA/X drive supports "hot" insertions and removals, I've discovered that, every so often, my system reboots when I remove the memory card. This inconvenience seems to occur arbitrarily, and I've yet to track down the cause. One other problem with the ATA/X is its lack of a cover for the opening in the drive. This makes it easy for dust and other debris to easily enter both the drive and the system. It should be mentioned that the drive supports PCMCIA-ATA Type II FLASH cards and Type III 1.8" hard disks from such vendors as Sundisk, Epson and Western Digital. Unfortunately, I didn't have one of the diminutive hard drives available for testing. The internal ATA/X drive is reasonably priced at $99.95, and

an external model is available for $179.95.

What's left to be said on this subject? Well, there's the little matter of the litigation between Microsoft and Stac Electronics, Inc. In late February, Microsoft removed the DoubleSpace feature from MS-DOS 6.2. DOS 6.21 doesn't include data compression capability. A US District court ruled that the compression technology in MS-DOS 6.x violates patents held by Stac Electronics, Inc. At the time of this writing, all the issues hadn't been resolved. But these lawsuits could eventually affect your ability to transfer data via a compressed PCMCIA memory disk.

Coupling to the Phone Lines

Years ago, before modem boards and external modems became popular, you could transfer data over the telephone lines by means of an acoustic coupler. These fell out of vogue, though, for a variety of reasons. A major one was the changes that occurred in the style of the handset. Old-time acoustic couplers were designed for old-style phones.

One advantage of acoustic couplers is their ability to connect to phone lines without you having to worry about availability of a phone jack. This is mostly a problem in hotel rooms, though it's being addressed by more and more hotel chains nowadays. Finding a jack also could be a problem in a foreign country, for example.

Another problem that crops up with modems is their inability to connect to digital telephone systems. This could be a problem in certain offices that lack analog telephone lines.

A handy solution to these problems is a gadget from Unlimited Systems Corp. called the KONEXX Koupler computer telephone interface. This isn't an acoustic coupler *per-se* since it doesn't include a modem. Instead, it connects to a modem. The interface, which looks like a small walkie-talkie, straps to the handset of the telephone instrument and allows you to connect to digital, PBX, cellular and international systems. You can also connect the device to a public pay phone. The Koupler supports speeds up to 14.4 kps and sells for $149.

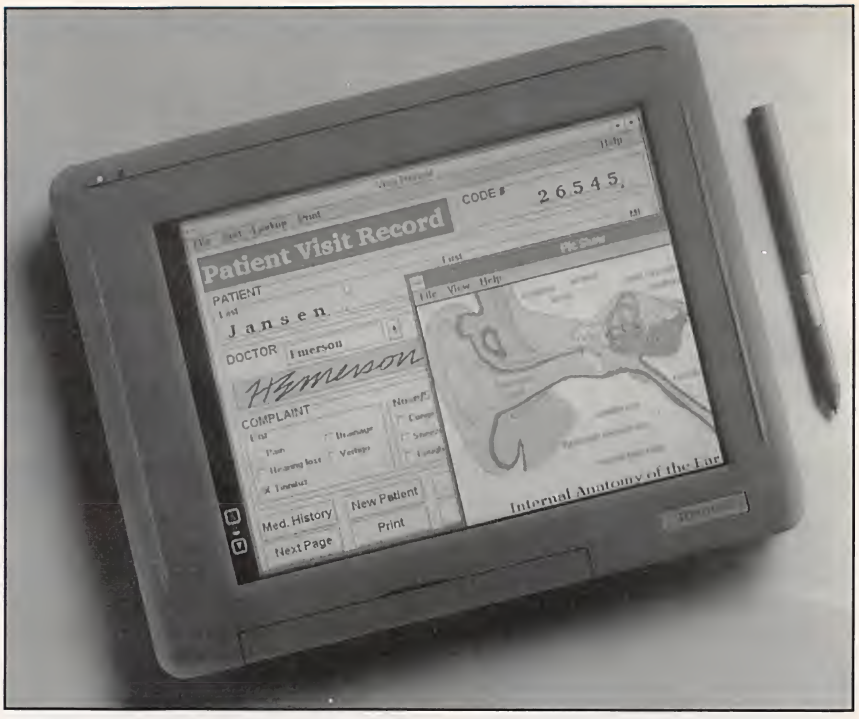
I tried the Koupler on my office phone system. Usually, I need to share an analog line with the office staff, and it isn't always available when I need it. In addition, the jack is in a difficult-to-reach spot in another part of the office. I have to run a long line to the jack whenever I want to make a connection.

I hooked the Koupler to my telephone handset and plugged the Koupler's RJ-11 connector into the "Line" connector on my internal modem. Using *Procomm*, I selected MCI Mail, just as I normally do and observed what occurred. I didn't connect the first time because the handset had been off-hook a little too long a time and I'd I lost the dial tone. So I just pressed the receiver button on the telephone to regain the dial tone and tried MCI again. I got a connection without a problem.

Now I thought I would try connecting to the Epson ActionNote 4000 notebook PC, which has a PCMCIA fax/modem card installed. The only problem here was that the fax/modem card didn't have an RJ-11 connector. Instead, it has a special cable with an RJ-11 connector. The solution is a connector with RJ-11 jacks on both ends, which you can purchase at any electronics or telephone store. I looked around the office for one of these connectors and found it right away.

This time, I tried to connect using the *Windows* Terminal program. After two unsuccessful tries, in which I don't think I waited long enough to make the connection, I got through to MCI mail. The Model 204 is certainly a convenient device to carry around if you aren't certain about the status of the phone lines at your hotel, but it also is a good solution when you're at an office where you can't easily connect to an analog line.

Two other products are similar to the Model 204. One is the KONEXX Modem Koupler Model 30, which combines an acoustic coupler with a 2,400-baud data/9,600-baud fax modem and sells for $299. The other is the KONEXX Kit, which includes the Model 204, a 7-foot modular telephone cable, alligator clip adapter, duplex adapter, Merlin phone adapter, spare 9-volt battery, combination Phillips/standard screwdriver and carrying case and sells for $169.



Toshiba's DynaPad color pen tablet features a 6-hour battery, 3.3-volt 486 OX2/40 cpu, 4M of RAM, 80M harddrive, hardware graphics accelerator and more.

Some Other Items of Interest

I visited the Lap & Palmtop show at the New York Hilton in March and came across some interesting products. First is MosesDOCK! from Moses Computers. This product is a laptop-to-PC *Windows* linking and networking solution. It lets you connect laptops with PCs to share files, drivers and printers, and connect with a peer-to-peer network. MosesDOCK! retails for $299.95.

Connectivity seems to be on the minds of many laptop users. Another product that will help you connect to your desktop is called JetEye LT from Extended Systems and Traveling Software. This is a complete wireless solution to data transfer between a portable and desktop PC. The package includes two infrared adapters from Extended Systems and *LapLink Synchro Plus* software from Traveling Software. *LapLink Synchro Plus* synchronizes data between the two computers and can be configured for either automatic or

Products Mentioned

ATA/X
ProTégé Corp.
4165 East La Palma
PO Box 68031
Anaheim, CA 92817
Tel.: 714-961-7030; fax: 714-961-1162

CIRCLE NO. 128 ON FREE INFORMATION CARD

Sundisk 10M Solid State Mass Storage System
Sundisk Corp.
3270 Jay St.
Santa Clara, CA 95054
Tel: 408-562-0500; fax: 408-562-0503

CIRCLE NO. 129 ON FREE INFORMATION CARD

KONEXX Koupler Model 204
Unlimited Systems Corp.
8586 Miramar Pl.
San Diego, CA 92121
Tel.: 800-275-6354

CIRCLE NO. 130 ON FREE INFORMATION CARD

MosesDOCK!
Moses Computers, Inc.
15466 Los Gatos Blvd., Ste. 201
Los Gatos, CA 95032
Tel.: 408-358-1550; fax: 408-356-9049

CIRCLE NO. 131 ON FREE INFORMATION CARD

JetEye LT
Extended Systems
5777 N. Meeker Ave.
Boise, ID 83704
Tel.: 208-322-7575; fax: 208-377-1906

CIRCLE NO. 132 ON FREE INFORMATION CARD

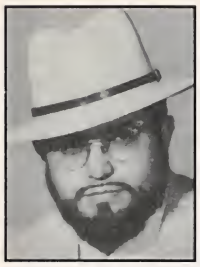
Dynapad T200
Toshiba America Information Systems, Inc.
PO Box 19724
Irvine, CA 92713

CIRCLE NO. 133 ON FREE INFORMATION CARD

manual operation. The infrared modules use Hewlett-Packard's serial infrared technology, HP SIR. If you own an OmniBook computer, you need only one module because the OmniBook has an infrared serial port. If you own another type of portable, you need to connect one of the modules to its serial port. The desktop receiver connects to desktop's serial port.

Once installation is complete, you have to line up the infrared module on the portable computer with the infrared module on the desktop computer. The IR connection runs at a speed of 115,200 baud. Introductory price for JetEye LT is $199. JetEye for the HP OmniBook retails for $159.

Toshiba was showing its new DynaPad T200, a color pen tablet. Its features include: a lithium-ion battery that provides it up to six hours of battery life; a 40-MHz, 3.3-volt i486DX2 processor, local bus video; hardware graphics accelerator; 80M hard-disk drive; and 4M of RAM that's expandable to 20M. The display is a $9\frac{1}{2}$" dynamic STN dual-scan color screen. This unit also includes one each Type II and Type III PCMCIA slots. Pricing hadn't been announced at the time of this writing. ■



By Yacco

GUI Guts

Getting the Big Picture

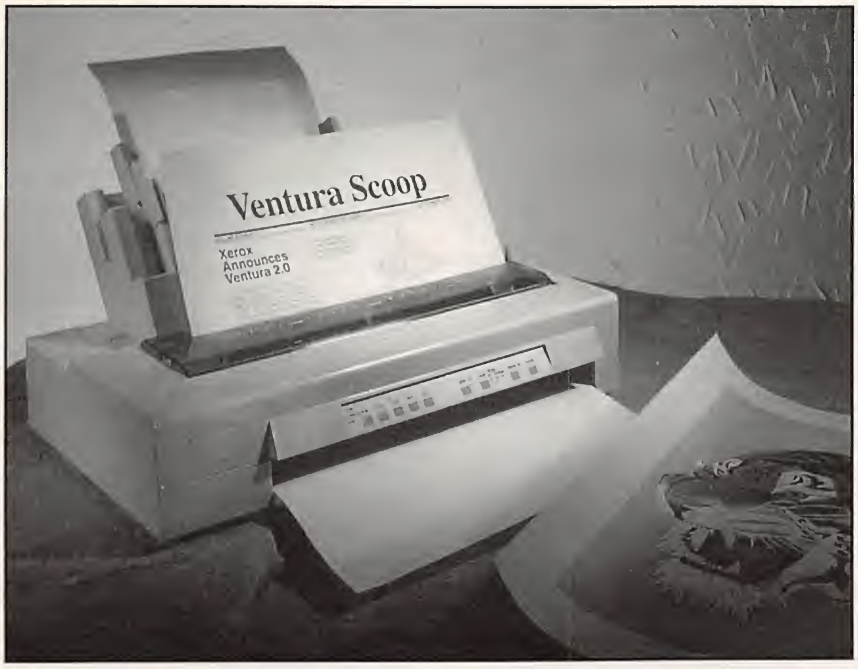
The *Windows* graphical interface is such an overwhelming improvement over the command prompt that it's easy to overlook the many other advantages the *Windows* environment provides. Most of us are familiar with at least some of the features that *Windows* adds to the operating system, including font support, application integration, inter-process communication, multitasking, etc. But there are also those subtle advantages that can escape our attention because, although we benefit from them, we're not using them directly.

One of those subtleties are the benefit that users derive because hardware vendors are able to support all *Windows* applications with a single driver. As *Windows* became widely adopted, this allowed developers to support a large installed base of users without relying on emulation of the industry's *de-facto* standards. As the potential market for their products opened, they were able to include features beyond those that the standards were designed to support—without the need to write drivers for individual applications. Reducing driver development cuts costs and leads to less-expensive as well as more richly-endowed products.

The DOS environment relied on adoption of *de-facto* standards to support its applications. These include sound standards set by Sound Blaster and Ad Lib drivers, as well as the familiar Hayes standard for modem commands. For printer vendors, the industry's standards were set by the Hewlett-Packard LaserJet (HP PCL) and the Apple LaserWriter (Adobe PostScript). The languages in these printers have broad applicability. However, applications vendors tended to design their drivers for, and test them on, these printers. Such drivers are limited to the printer languages as implemented in these particular devices. PostScript, for example, can support color, but a driver designed for a monochrome LaserWriter wouldn't be likely to support color. Likewise, drivers designed for devices that handle only A and B paper sizes aren't likely to provide for printing on larger formats. Before *Windows*, that fact of life either limited the availability of additional features or made printers with extended feature sets more expensive.

By allowing developers to support a large number of applications with a single specialized driver, *Windows* made it economically feasible to break the feature limits imposed by standard drivers. Breaking the installed-base stranglehold means that vendors can develop all sorts of innovations. This is why printers are now being offered in a wider range of choices than ever before. To some extent, this is simply a result of advances in technology. But these machines are also arriving at prices that are made possible by the economics of the *Windows* environment. For example, take Fargo's under-$1,000 Pri-

Fargo Electronics' $995 Primera is a wax thermal-transfer printer that, for the cost of a $250 software/print upgrade kit, can be set up to do dye-sublimation printing.



Pacific Rim Data Sciences BP3670 bubble-jet printer handles letter, legal, ledger, tabloid and 17" x 22" C-size paper and continuous-form printing requirements at an affordable $795.

mera Color Printer. The original Primera wax thermal-transfer color printer was, at least in part, made practical by its *Windows* driver. The Primera now has a dye-sublimation option that produces continuous-tone output and retrofits to the printer through the simple addition of a new driver. That's not one replacement driver for every color application, as a DOS driver would require, but one driver for *any* and *all* applications that run under *Windows*. Thus, you can use the new option to produce the slickest imaginable artwork from *CorelDRAW* or Micrografx *Designer*, or charts and graphs with *Harvard Graphics*, Lotus *Freelance* or Microsoft *PowerPoint*. The low-cost upgrade kit also contains a dye-sublimation ribbon that produces your first 10 prints. Additional prints require refills that are available in kits of 25 prints for $89.95 and 100 prints for $279.95.

The Primera's 260 X 260 dots per inch (dpi) places its resolution midway between the 200 X 200- and 300 X 300-dpi resolution of dye-sublimation printers that cost thousands of dollars more. An input tray holds up to 50 sheets of either A (8.5" X 11") or A4 (210 X 297-mm) paper or transparencies. Legal sizes are also supported in both the A and A4 formats.

Fargo's Primera printer also has one internal 12-point font—Letter Gothic—that enables it to print text from DOS. The print engine produces output at the rate of one page every 2.5 minutes. However, your output must first be composed by a raster image processor (RIP). For Primera, the image is created by the printer's driver. Since the driver runs in your host computer, all this processing takes place in the host CPU and memory. It's then transferred to the printer. This can take from a few seconds to several minutes, depending on the speed of your processor and complexity of the image to be printed. Photo-realistic images are at the longer end of this spec- trum, and simple charts and graphs are at the shorter end. Unfortunately, other tasks are delayed while this processing takes place. But having the driver process images in the host computer eliminates the need for a processor in the printer, and this is a major reason why this printer's so inexpensive. It's an ideal solution for anyone whose modest color printing volume doesn't interfere with their ability to run other applications or justify the expense of a $5,000 printer.

Incidentally, in addition to its new dye-sublimation ribbon, Primera still operates with it's standard thermal-wax ribbons. Considering the cost of dye-sublimation prints, you'll probably want to use the wax ribbons for comps, before committing to your final dye-sub output. Three-color ribbons cost $45 for 115 prints. Four-color ribbons cost $45 for 80 prints. Monochrome ribbons that can produce 360 black-and-white or 64 gray-tone prints, run just $39.95. If you plan frequent changes between dye-sublimation and thermal-wax ribbons, and/or between color and monochrome ribbons, extra ribbon holders will let you quickly make your transitions without fuss. They're available for $19.95 apiece.

Special paper is required by this printer. It's available in 200-sheet quantities in two grades. Standard grade sells for $14.95, and heavily coated premium grade costs $19.95. A special perforated version of premium grade is also available for $21.95 per 200 sheets. The perforations permit easy removal of the sheet ends, which are gripped by the printer during the repeated passes required for color printing.

Fargo also offers thermal transparencies and T-shirt transfer paper. Transparencies list for $34.59 per 50 sheets. Transfer paper lists at prices that range from 85 cents to $1.90 per page in quantities ranging from 10 to 500 sheets.

Pacific Rim Data Sciences Bubble-Jet Printer

Pacific Rim's 360 X 360-dpi BP3670 printer is another case in point. This PostScript-driven bubble-jet printer is supported by major CAD/CAM and graphics software, as well as by all serious desktop- publishing software. It's based on the same Canon P670 printer technology that's used by Pacific Data Products for a PostScript printer in the $3,200 price range, and it can print on three paper sizes, ranging up to 17" X 22". Yet the BP3670 lets you print C-sized drawings for less than $800. (GCC sells its WideWriter, also a version of the P670, for roughly $1,500. However, WideWriter is a *QuickTime* printer.) Furthermore, as a PostScript printer, the BP3670 is as capable of producing pre-press comps for later image-setter output as it is of printing finished copy.

Two factors have helped the BP3670 keep down its price. One is that Pacific Rim originally developed this printer's SCSI hardware interface for another vendor and acquired its inventory in a subsequent settlement. The BP3670 is the same printer formerly sold by Bezier. Nevertheless, the BP3670 isn't an orphan. Pacific Data is the actual developer of this version of the printer, and Canon still sells the basic OEM hardware on which it's based.

The other cost-cutting factor is that Pacific Rim, like Fargo, processes images for the printer in the host computer's CPU and memory. Thus, the printer is just a bare engine. In this case, image processing is done by Zenographics' *SuperPrint*, which serves as the printer's driver. *SuperPrint* also provides special font-handling and spooling features.

Despite being a dumb printer that relies on host resources, the BP3670 offers rea-

sonable performance. The printer is able to take advantage of the wide bandwidth and high data-transfer rate of its interface. A typical C-size architectural plot can require as little as two minutes of dedicated printing, depending on your CPU and memory (a minimum 4M of RAM is required). Standard A-size letters are produced at a rate of about four pages per minute. Furthermore, *SuperPrint*'s background printing allows you to return to your application faster.

Pacific Rim includes a double-bin automatic sheet feeder for A and/or B (11" X 17") sizes. It can be used with either one or both sizes simultaneously. The larger C-sized (17" X 22") paper must be manually fed through a special front slot. The front slot is also handy for feeding any occasional odd-sized form or envelops. In addition to the double bin (which can be separated to function as a single bin) and the front slot, the BP3670 also features a tractor for feeding forms up to 14.7" wide. Special controls eliminate the need to remove tractor-fed forms while printing sheets.

Ink cartridges for the BP3670 run $25 each. Each cartridge produces about 250 A-sized pages of text or perhaps 50 C-sized drawings. One more note: Unlike most parallel printers for the PC that use the Centronics interface, the BP3670 is a SCSI device. If you already have an ASPI-compliant SCSI controller and driver, you're ready to plug it in and set up it's software.

Of course, a SCSI requirement can be a problem for some machines, and portable computers don't often provide this interface. Fortunately, there are now PC Card interfaces from companies like QLogic and New Media that can provide SCSI on the latest generation of portable computers that feature PCMCIA slots. Both the QLogic Fast!SCSI PCMCIA and the New Media Bus Toaster PC Cards include the ASPI driver required by the BP3670 printer. Both also provide a cable with a standard 50-pin Centronics connector of the kind required for direct connection to the printer. However, these are rather short cables. If you want a longer connection, you can use a SCSI extension cable with either.

New Media also has optional cables, including one terminating in a 25-pin D-shell connector of the type used by the Macintosh and frequently used for SCSI adapters on the PC. This connector will work with the long SCSI cable shipped with the printer.

If your computer has a PCI bus, QLogic is also shipping a brand-new Fast!SCSI IQ PCI card with ASPI drivers. All three of these interface cards also include the Corel SCSI drivers for use with more than 350 other SCSI devices.

Advanced Communications Enhancement Adapter

Windows drivers have the same impact on hardware offerings besides printers. In the past, the industry tended to standardize on any popular product that gave it a hook on which to hang a market. The Hayes modem commands as well as the Sound Blaster and Ad Lib sound interfaces were other standards that evolved in this manner. Today, *Windows* lets this trend turn around and head in the opposite direction.

For instance, Best Data Products has just shipped an Advanced Communications Enhancement (ACE) adapter for *Windows*. DOS drivers aren't available yet and, when they are, will probably be limited to support for the Sound Blaster and Ad Lib standards. DOS drivers for functions other than sound will probably be slow in coming months and limited to a small number of applications when and if they do appear. This is because this multifunction communications device is much more than a fax/data modem, and there are no standards for many of the features it either offers or eventually will offer.

The ACE currently provides a voice-mail system, MIDI player with wave-table synthesis for 128 instruments and a CD-ROM interface for Panasonic's double-speed CD-ROM drive Models 562 and 563. In addition, a MIDI-port option is available, and many others are planned. Upgrading is simple because the board is based on IBM's MWave DSP chip. So, when a 28.8K-bps modem standard is adopted by the industry, Best Data will be able to double the data rate of its modem with only a software change. A 10:1 audio compression upgrade is planned, as are caller ID and distinctive ring functions. So are major features like voice recognition and speech-to-text planned. The MWave chip is even capable of supporting video for such applications as picture phones and video-conferencing. In addition to its Berg-strip connector for an internal CD-ROM, the ACE includes two external RJ-11 telephone connectors and three external mini phono jacks for a microphone, analog input and speaker output. Software includes a talking alarm clock, a utility to record and edit digital sound files, a MIDI sequencer and controls for audio levels, MIDI files and CD music tracks.

Multimedia Cloaking

Helix, the folks that developed Cloaking

technology to let you stuff more stuff into your computer's memory, have taken that very same mysterious code from its *NetRoom* memory-management product and put it into a stand-alone product the company calls *Multimedia Cloaking*. Cloaking itself is an API, as well as a device driver that provides an API, that lets programs run in 32-bit protected mode. Cloaking is similar to a DOS extender, but it's designed for TSRs and installable drivers, rather than the applications themselves.

The purpose of Cloaking is to speed up your drivers. Port access is faster because Cloaking runs drivers in ring 0. Interrupts are faster because they're in protected mode whenever a memory manager is present, and since you're already in this mode, you don't have to undergo a change of state. Finally, the 32-bit instruction set has a data-transfer advantage.

Mulitimedia Cloaking uses this technology to provide a protected-mode version of MSCDEX, the Microsoft CD-ROM driver extensions. Helix licensed the genuine code from Microsoft and then used protected mode to speed it wherever possible while maintaining full compatibility with the original code. The 32-bit instructions in this protected-mode version of the driver move data 10% to 20% faster, depending on your CD-ROM drive.

Obviously, switching back and forth between protected and real modes involves execution of a few extra instructions. Helix claims that this doesn't degrade performance. *Multimedia Cloaking* switches back and forth in about 100 clock cycles—about the same time it takes to switch to a driver, anyway. And Cloaking more than makes up for this time, the company claims, by running the driver in protected mode. In addition to taking advantage of 32-bit instructions, the cloaked driver also requires less conventional memory than the standard MSCDEX driver, equating to 2.5K *versus* 36K.

Multimedia Cloaking also comes with a cache and a replacement mouse driver. The product's cache can raise the speed of your CD-ROM by as much as 10 times when compared with an un-cached drive, and by as much as 50% when compared with a drive cached with other software, such as the 16-bit SmartDrive cache that comes with MS-DOS. The mouse driver replacement uses only 832 bytes of conventional memory *versus* roughly 30K for the standard driver. Like its CD-ROM counterpart, the mouse driver also runs without taking a performance hit. It's compatible with the Microsoft Mouse Driver Control Panel, too.

At less than $40 list price, the cost-benefit analysis for *Multimedia Cloaking* shouldn't be a deterrent to anyone who needs either more conventional memory or improved CD-ROM performance—or both. And which multimedia user doesn't need more of both of those commodities?

Products Mentioned

Advanced Communications Enhancement Adapter, $259
Best Data Products, Inc.
21800 Nordhoff St.
Chatsworth, CA 91311
Tel.: 818-773-9600

CIRCLE NO. 174 ON FREE INFORMATION CARD

Primera Color Printer; $995; Dye-sublimation software and 10-print upgrade kit, $249.95
Fargo Electronics, Inc.
7901 Flying Cloud Dr.
Eden Prairie, MN 55344
Tel.: 800-327-4622 or 612-941-9470

CIRCLE NO. 175 ON FREE INFORMATION CARD

Multimedia Cloaking, $39.95
Helix Software Co.
4709 30 St.
Long Island City, NY 11101
Tel.: 800-451-0551 or 718-392-3100

CIRCLE NO. 176 ON FREE INFORMATION CARD

Bus Toaster, $299
New Media Corp.
15375 Barranca, Bldg. B-101
Irvine, CA 92718
Tel.: 714-453-0100

CIRCLE NO. 177 ON FREE INFORMATION CARD

BP3670 Bubble-Jet Printer, $795
Pacific Rim Data Sciences
48531 Warm Springs Blvd., Ste. 415
Fremont, CA 94539
Tel.: 510-226-8930

CIRCLE NO. 178 ON FREE INFORMATION CARD

Fast!SCSI PCMCIA, $214.95
QLogic Corp.
3545 Harbor Blvd.
Costa Mesa, CA 92628-5001
Tel.: 800-662-4471

CIRCLE NO. 179 ON FREE INFORMATION CARD

Microcomputer Q&A

By TJ Byers

In this column, I answer questions about all aspects of computer disciplines, both hardware and software, plus related electronic queries. Since I draw from a large source of knowledgeable contributors, feel free to ask whatever questions you may have regarding computing on the PC platform. Address your queries to me care of *MicroComputer Journal,* 76 North Broadway, Hicksville, NY 11801.

Installing a Faster Crystal

Q: *I was wondering if it's possible to change the 40-MHz crystal in my PS/2 model 70 to a 50-MHz crystal, which will give me a 25-MHz 386? I heard that all you need do is put a heat sink on the 20-MHz 386 CPU and you're set. Sounds too easy—and tempting!Why can't I swap out my 20-MHz 386 CPU with a 33-MHz 386 CPU and change the crystal on the motherboard to 66 MHz?*

A: Going to 25 MHz by upgrading the crystal to 50 MHz is okay. Go for it—if you think you have the mechanical skills to replace it. Also, remember that your CPU has been tested to only 20 MHz (all CPU crystal frequencies are twice the operating frequency). So there's an outside chance you can get unexpected errors. But I doubt it. I'm not sure if you'll need a heat sink or not. The best way to tell is to touch the chip after the system's been running for a while and feel how hot it gets. As for swapping out the CPU and going to 33 MHz, this sounds pretty iffy. Keep in mind that the motherboard has been tested to only 20 MHz, and I don't know what other problems you may have with the other motherboard components and clocks...so, good luck.

Calling CompuServe From AOL

Q: *I just bought a PC clone, which included a subscription to America Online and Prodigy. My brother and uncle both use CompuServe. Is there a way I can send them e-mail? I'm not sure if they use Internet.*

A: The services you mention all have an Internet link for messages. All you have to know is your brother's and uncle's log-on names, plus the network's name. For example, anyone can reach me at tjbyers@aol.com (note the period between AOL and COM) through any service. The trick is the @ symbol, which in this case steers the message to America Online. Using *name*@CompuServe.com directs the message to CompuServe (see Fig. 1).

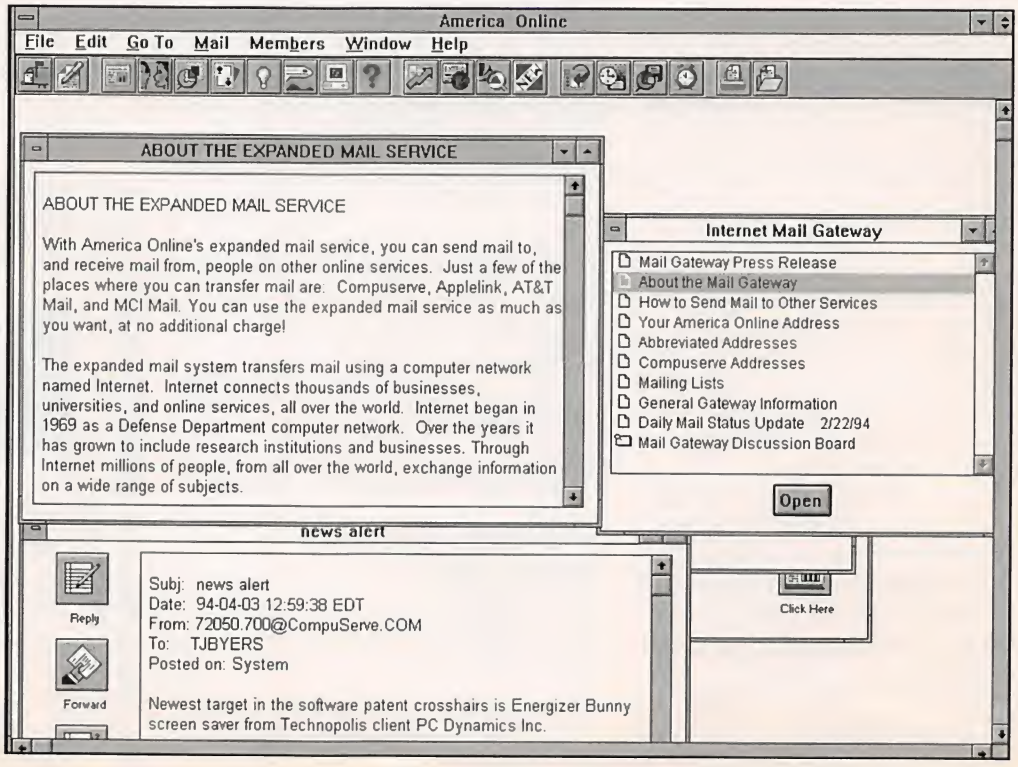
Of Mice and Men

Q: *What is the difference between a serial mouse and a PS/2 mouse?*

A: The difference is the connector. The serial mouse uses a nine-pin D-shell connector and the PS/2 mouse has a round DIN connector. Other than this, the two work the same and use the same software drivers.

Needs to Control House Outlets

Q: *I'd like to control 120-volt ac outlets in my house using my computer's internal clock as a reference to*



switch on/off lights and electrical appliances at different times of the day via a serial port or special card in the PC. What can you tell me about this subject?
A: The December 1993 of *ComputerCraft* (the former name of *MicroComputer Journal*) has an article by Steve Montgomery that describes exactly what you're looking for. It's based on proven X-10 technology, which is commonly available. This article also tells you how to build your own PC interface. Back issues of *Computer Craft* and *MicroComputer Journal* are available by writing to CQ Communications, 76 North Broadway, Hicksville, NY 11801, or you can call 516-681-2922.

Phone Surge Protection Revisited

Q: *In the March 1994 issue, you write about adding an MOV onto the incoming phone lines to protect against electrical surges. Do you need to connect the MOV on each individual leg of the phone lines (four MOVs for four wires) in series, or across the lines in parallel?*
A: The MOV goes across the phone lines in parallel. If you have one phone, it goes across the red and green wires. If you have two phones (two different phone numbers) you'll need a second MOV across the yellow and black wires. The Radio Shack part number for the MOV is 43-102.

DoubleSpace Obituary

Q: *One man's opinion: Trash DoubleSpace, if you're using it, ASAP. Now that it's been orphaned, neither Microsoft nor any other vendors will be obligated to support it—or, more importantly, to make their future programs compatible with it. And disk compression is insidious because the longer you use it, the more dependent on it you become. Someday, when your 120M drive has 200M of data piled onto it, you'll wish you'd bought a larger-capacity drive instead. And a 200M IDE drive isn't much more expensive than* Stacker *with a couple upgrades.*
A: For those who haven't heard, Microsoft has dumped DoubleSpace for legal reasons. The company no longer sells or supports it. Notwithstanding this, the suggestion above is well taken. It's better to buy into a larger-capacity hard-disk drive than it is to compress it.

Can't Get Rid of DoubleSpace

Q: *I recently upgraded my hard drive and decided to stop using DoubleSpace. Microsoft's tech support gave me assistance in deleting it, but I still have DoubleSpace items in my root directory, and I find that DoubleSpace is still using some conventional RAM. I tried to REM out the DoubleSpace lines in my CONFIG.SYS file, but it still uses memory. How can I eliminate DoubleSpace altogether?*
A: I assume you've backed up your files and that the compressed drive is clear of all files. If not, do it now. Then try the following. Start by making sure that there are no DoubleSpace references whatsoever in your CONFIG.SYS and AUTOEXEC.BAT files. Next you need to locate the hidden files in your root directory using the DIR C: /A command. You should find three that are DoubleSpace-related: DBLSPACE.BIN, DBLSPACE.INI and DBLSPACE.000. These, too, have to be removed—but first you have to unhide them using

```
ATTRIB -H C:\DBLSPACE.*
```

This done, you can delete all DoubleSpace files using DEL C:\DBLSPACE.*. *Caution*: Do *not* tamper with these files if you still have files on the compressed drive. If you change or delete the hidden files before you back up your compressed drive, you might lose your data.

Unix on the PC

Q: *Unix is coming up in my life and, as a DOS and* Windows *person, I don' t know how to define it in comparison. For example, can Unix and DOS reside on the same hard disk? Can Unix handle process controls as well as digital information? Does Unix run on Novell* NetWare*? What kind of network server is needed for LAN communications? Can you suggest a book that will give answers to these and similar questions?*
A: Like DOS and OS/2, Unix is an operating system that closely resembles *Windows NT* in the way it's structured. While you can have both DOS and Unix loaded on the same hard disk, you can run only one at a time. Generally, you choose the operating system when you boot the PC. Unix often gets a bad rap because many people think it's a program written by programmers for programmers and that it's totally unsuited for PC use. Nothing is further from the truth. In fact, it's doubtful you'll ever have to write a line of Unix code. Most of the time you'll be running such PC applications as word processors and spreadsheets just as you do in DOS. In fact, Unix-based *WordPerfect* is as popular and easy to use as its DOS counterpart. However, be aware that there are several different versions of Unix, and you have to use the application software written for your specific Unix version. The most popular Unix is *Solaris* from Sun Microsystems (tel.: 1-800-426-5321). Be prepared to buy a 486DX-66 or Pentium system, because Unix has a voracious appetite for speed and memory. As a rule, network software is already built into Unix and works with most servers, includ-

WHAT'S NEW!

(from page 14)

headings and body text, and a "background mode" in which background scenes with images, text and draw objects can be defined and saved as templates. $199. *Q/Media Software Corp., 312 E. Fifth Ave., Vancouver, B.C., Canada V5T 1H4; tel.: 604-879-1190; fax: 604-879-0214.*

CIRCLE NO 35 ON FREE CARD

Windows Statistics Upgrade

The latest version of Kalmia's *WinSTAT*, a statistics program for *Windows*, adds new presentation-quality graphics to its array of statistical methods. Text can be displayed in any installed font, and color and graphics can be shown in 2D or 3D at various angles and perspectives.

Version 3.0 also features new statistical methods, including percentiles, geometric mean and trimmed and winsorized mean. Other improvements are a calculation of means with any desired confidence interval and 2-factor ANOVA without interaction. $495. *Kalmia Co., 71 Dudley St., Cambridge, MA 02140; tel.: 617-864- 5567; fax: 617-864-5567.*

CIRCLE NO 36 ON FREE CARD

Multimedia Software Upgrade

Ask Me Multimedia Centers *SST* 1.1 multimedia presentation package includes 20 new features. Among the most-important of these are enhanced memory management, advanced branching capabilities, new transitional effects, the ability to preview a slide before jumping to it, action within action and improved video production features. The upgrade is being offered free to registered users. $149. *Ask Me Multimedia Center, 7100 Northland Cir., Ste. 401, Minneapolis, MN 55428; tel.: 612-531-0603; fax: 612-531-0645.*

CIRCLE NO 37 ON FREE CARD

ing Novell's *NetWare*. An excellent Unix book for the first-time user is *UNIX and Xenix Demystified* by Lee Paul Clukey from Tab Books.

Needs More Upper Memory Blocks

Q: *I run* Windows *on a 486DX-33 PC, and I'm running out of UMBs (upper memory blocks), which causes some device drivers to load in conventional memory. The* Windows Resource Kit *said that the Dual-Display entry lets you run* Windows *in enhanced mode when EMM386.EXE has included this address range as UMBs. But I can't get it work. Do you have any ideas?*
A: Well, it sounds like the *Windows Resource Kit* book is in error. The EMM386-.EXE command line in CONFIG.SYS *can't* contain include address range (I) switches. This is why it's not working. What's probably occurring is that your display driver is accessing the monochrome address range (B000 through B7FF), which it doesn't need, that prevents the memory manager from using this range for upper memory blocks. To open up this area for UMB use, add the line

```
DEVICE=C:\DOS\MONOUMB.386
```

to the [386ENH] section of the *Windows* SYSTEM.INI file. A full explanation of *Windows* 3.1 and memory managers is documented in the *Windows* README-.WRI file.

Hard Disk Full

Q: *Can anybody give me an answer to why I keep getting an error message saying drive C: is write protected or full when I try to add a new program or create a new directory? I'm using DOS 6.2 and* Windows *3.1. The problem comes and goes intermittently, but it seems to be worse with* Windows.
A: Most likely, your C:\ root directory has too many files in it. Unlike subdirectories, which can hold an unlimited number of files and subdirectories, the root directory is limited to 512 entries *total*, including files and subdirectories, some of which may be hidden. A simple DIR C:\/A command will tell you how many entries the root directory contains. To fix the problem, sort through the program files and move related items to a directory of their own. For example, if you installed your DOS files in the root directory, you can open up space for about 125 new directories by moving them to the C:\DOS directory. If this isn't the problem, do a CHKDSK or SCANDSK check of your hard disk to see if you have a high number of lost or cross-linked sectors.

Vi-Spy

Q: *Could you please supply the address for RG Software Systems, suppliers of the* Vi-Spy *antivirus program?*
A: The company can be reached by calling 602-423-8000 (voice) or 602-423-8389 (fax). The program lists for $149.95 and comes in both DOS and *Windows* versions.

Dallas Semiconductor Info

Q: *I live in Malaysia and have been a reader of your magazine since 1989. I'm having a problem finding information on the Dallas Ramified Timer DS1386 chip. If you know where I can get a pinout of the chip plus other operating information, I'd much appreciate it.*
A: Write to Dallas Semiconductor directly at 4350 S. Beltwood Pkwy., Dallas, TX 75244-3292. If you have a copy of the January/February issue of *MicroComputer Journal,* you can contact Dallas Semiconductor by circling No. 111 on the enclosed Free Information Card if you add the needed postage. In case you need a chip, it can be purchased from Newark Electronics for about $30. ■

WHAT'S NEW!

Professional Write Upgrade

Professional Write 3.0 for DOS from Software Publishing offers new enhancements and features designed to give users greater ease of use and speed throughout the document-creation process. Version 3.0 sports a streamlined user interface and offers expanded mouse support. It also offers expanded support for printers and a range of new view options to help in reviewing and revising work more quickly. $249. *Software Publishing Co., 3165 Kifer Rd., PO. Box 54983, Santa Clara, CA 95056; tel.: 408-986-8000.*

CIRCLE NO 38 ON FREE CARD

Data-Controller Program

Advanced Electronic Applications' *PC Pakratt for Windows* is an application for controlling the entire AEA family of data controllers, including the PK-232MBX, PK-88, PCB-88, PK-900, DSP1232 and DSP2232. It supports standard control-program features, such as split-screen operation, binary file transfers, QSO logging, macro facilities, on-screen status display, and more. Supported modes include PACTOR, Packet, AMTO/SITOR, Morse, RTTY, NAVTEX, TDM, and SIAM. $129. *Advanced Electronic Applications, PO Box C2160, Lynwood, WA 98036; tel.: 206-774-5554; fax: 206-775-2340.*

CIRCLE NO. 39 ON FREE CARD

Super Show & Tell

SST from Ask Me Multimedia Center is multimedia presentation software that lets you to create interactive multimedia presentations in a free-form environment. It supports all popular graphics-animation, sound and digital video formats. Presentations developed with *SST* use a slide carousel as a metaphor and include sound and motion without having to use an authoring language. $149. *Ask Me Multimedia Center, 7100 Northland Cir., Ste. 401, Minneapolis, MN 55428; tel.: 612-531-0603; fax: 612-531-0645.*

CIRCLE NO. 40 ON FREE CARD

DoubleSpace De-Installer

IIT's DeDouble is a new utility for *XtraDrive* 3.0 and *XtraDrive Lite* that de-installs DoubleSpace, the data-compression product bundled in MS-DOS 6.0. *XtraDrive* is data-compression software for IBM PC/compatible computers that effectively doubles the capacity of any hard-disk drive. DeDouble uncompresses files compressed by DoubleSpace, without the need to reformat a hard drive. After de-installation, you have the option of installing *XtraDrive*. *XtraDrive Lite* was exclusively developed for systems with hard drives with capacities up to 130M. $79.95/$34.95, *XtraDrive* 3.0/*XtraDrive Lite. Integrated Information Technology, Inc., 2445 Mission College Blvd., Santa Clara, CA 95054; tel.: 408-727-1885; fax: 408-980-0432.*

CIRCLE NO. 41 ON FREE CARD

Auto-Might Professional Upgrade

Auto-Might Professional, Version 2.0 from The Pendulum Group is an automatic event processor and keyboard macro package. The program lets you

schedule programs to run automatically when your computer is unattended. The package comprises two memory-resident utilities that can be used together or independently—the event processor and a new keyboard macro utility called AutoKey. New features include a "record mode" that memorizes keystrokes to be used in events or as hot keys, an expanded keystroke field, larger event files, new security options, additional network compatibility, DOS 6.0 compatibility and new easy-installation procedures. $169. *The Pendulum Group, Inc., 333 W. Hampden Ave., Ste. 1015, Englewood, CO 80110; tel.: 303-781-0575; fax: 303-781-0562.*

CIRCLE NO. 42 ON FREE CARD

CoSession Upgrade

Triton's *CoSession ACS* is network communication software that provides modem sharing on *Novell* or *NetBIOS* networks via either dedicated or non-dedicated PCs. Version 6.2 adds support for intelligent multi-port serial cards, permits modems to be shared on workstations running *Windows* 3.X in enhanced mode and offers increased performance. The support of intelligent multi-port serial cards from Digi-Board and Star Gate Technologies increases the maximum number of modems supported by *CoSession ACS* to 99 per network and 32 per server. $345/$595/$1,295, two/ five/20-modem versions. *Triton Tech-nologies, Inc., 200 Middlesex Tpke., Iselin, NJ 08830; tel.: 908-855-9440; fax: 908-855-9608.*

CIRCLE NO.43 ON FREE CARD

Satellite Database

Baylin's *Satellite Toolbox* all-purpose satellite software program consists of four parts. Satellite Database lists all communications satellites and the programming they relay. The Aiming Section automatically calculates magnetic deviation, compass heading, azimuth bearing and aiming angles for a polar or modified polar mount. With the Antenna Sizing section, you can choose the proper antenna size, LNB noise temperature and other system parameters, without having to use involved calculations. The Analysis component allows you to easily calculate virtually every parameter relating to satellite reception including antenna gain, beam width, focal distance as well as path loss, slant distance, G/T, C/N ration, video and audio S/N ratios and much more. Graphs and tables can be viewed on-screen or printed out. $95. *Baylin Publications, 1905 Mariposa, Boulder, CO 80302; tel.: 303-449-4551; fax: 303-939- 8720.*

CIRCLE NO. 44 ON FREE CARD

Scientist Upgrade

MicroMath's *Scientist* is a data-analysis and numerics package developed to meet the modeling and simulation needs of many disciplines. The program transparently processes models with both algebraic and differential equations. Version 2.0 includes a new memory-management feature that provides a 200% speed increase and stable performance. Also added are enhancements to handle a broader set of implicit and differential equations. A new graphics editor helps in producing publication-quality output. $495. *MicroMath Scientific Software, PO Box 21550, Salt Lake City, UT 84121; tel.: 801-943-0290; fax: 801-943-0299.*

CIRCLE NO. 45 ON FREE CARD

Storage Items

Leather Diskette Holder

Browning & Drum, a purveyor of fine business gifts, now offers a leather pocket-sized carrying case that holds two 3½" diskettes and a business card. Available colors are burgundy or black. $15.95. *Browning & Drum, PO Box 468, Brookline Village, MA 02147; tel.: 800-825-2060; fax: 617-566-4208.*

CIRCLE NO. 46 ON FREE CARD

Advertisers' Index

We'd like to see your company listed here too. Contact Margaret Milanese at 516-681-2922 to work out an advertising program tailored to meet your needs.

SuperMart

This new advertising section highlights products in an easy-to-locate format for reader convenience. Call Margaret Milanese today for deadlines and additional details at 516-681-2922 (FAX 516-681-2926).

EPROM+
PROGRAMMING SYSTEM USES PARALLEL PORT

SUPPORTS OVER 500 CHIPS

- *EPROMS* (24,28,32 & 40*PIN + 27C & 28?) 2708,16,32,32A,64,64A,128,128A,256,512,513,011 010,101,1001,1000,1024,210,020,2001,220,2048 4001,040,240, 2516,2532,2564,68764/66,TMS2716
- *EEPROMS* (24 & 28 PIN PLUS 28CXX) 2804,2816,2816A,2718,2864,2864A,2865,28256
- *SERIAL EEPROMS** (8 PIN PLUS CXX) 9306/46/56/66,2444,2401/02/04,85XX,ER1400
- *BIPOLAR PROMS** 74SXXX, 82SXXX
- *MICRO CONTROLLERS** 8741,42,48,49,8751 87CSX,87C751/752,68705,68HC705,TMS7742

* ADAPTER REQUIRED - DIAGRAMS INCLUDED

- SOFTWARE - READ, VERIFY, PROGRAM, COPY, DISK FILE LOAD & SAVE CHECKSUM, BUFFER EDITOR W/ 20 COMMANDS, HEX & BINARY FILES
- FAST! - MOST DEVICES PROGRAM IN UNDER 60 SECONDS
- RUGGED (8" X 7" X 3"), PORTABLE ENCLOSURE WITH CARRY HANDLE
- MADE IN THE U.S.A. - 10 DAY MONEY BACK GUARANTEE -1 YR. WARRANTY
- SYSTEM INCLUDES: UNIT, POWER PACK, CABLE, MANUAL & SOFTWARE

ANDROMEDA RESEARCH
P.O. BOX 222
MILFORD, OHIO 45150
(513)831-9708 FAX (513)831-7562

$289
ADD $5.00 SHIPPING $5.00 C.O.D.
VISA/MASTERCARD

CIRCLE NO. 55 ON FREE INFORMATION CARD

AFFORDABLE ENGINEERING HARDWARE / SOFTWARE

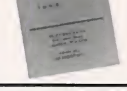
Engineering Software - PC-MSDOS

• Electronic Circuit Design	$ 49
• Schematic Drawing Program	$ 49
• PCB Design & Circuit Drawing	$169
• PC-SCOPE Oscilloscope	$ 49

PC Bus Plug-In Cards

• 24 Bit TTL I/O, 48 Bit TTL I/O	$39, 49
• 12 Bit Data Acquisition & TTL I/O	$ 89
• 16 Bit Counters & TTL I/O	$ 89

- More Hardware & Software is available -



Call or Write for FREE Catalog

BSOFT Software, Inc.
444 Colton Road
Columbus, OH 43207
(614) 491-0832
Fax (614) 497-9971

CIRCLE NO. 57 ON FREE INFORMATION CARD

AllMax
$645
Universal Programmer

- **Programs** PLDs, PROMs, E(E) PROMS, and microcontrollers
- **Tests** TTL/CMOS, DRAM/SRAM
- Supports standard **48-pin GOLD-ZIF** socket
- **AM-PRT** connects via printer port
- Lifetime Free Updates via B.B.S.
- **Two (2) year Warranty, Made in U.S.A.**

Electronic Engineering Tools
544 Weddell Drive, Suite 6
Sunnyvale, California 94089
(408) 734-8184, 734-8185 FAX

CIRCLE NO. 68 ON FREE INFORMATION CARD

SINGLE BOARD COMPUTERS

MCß8052
• 80C52-BASIC processor • Programs eproms, eeproms, nv ram • Three 8-bit parallel ports • RS232 port • Serial printer port • Four decoded outputs • Three 16-bit timer/counters • Six interrupt sources • Expansion headers • $119 A&T

MCß8031
• 8031 processor • 8k to 32k ram/rom • +5v only operation • Two 16-bit counter/timers • Five interrupt sources • Expansion headers • $79 A&T

TO ORDER ADD $5 S/H PER ORDER.
TN RESIDENTS ADD 8.25 S.T.

BLUE RIDGE Micros
2505 Plymouth Rd. Johnson City, TN 37601
Tel: 615-335-6696•Fax: 615-929-3164

CIRCLE NO. 61 ON FREE INFORMATION CARD

FORMULAS FOR BUSINESS SUCCESS

Know the correct decisions to make. Get today's best manual for professionals, based on the works of L. Ron Hubbard. at only $110.00
(FREE shipping)

TAKE THE GUESSWORK OUT OF MANAGEMENT

Send check or money order today to
WISE International
6331 Hollywood Blvd., LA, CA 90028.
Or call TOLL FREE 1 800-477-WISE.
Credit cards accepted

FREE
BUSINESS ANALYSIS

CIRCLE NO. 97 ON FREE INFORMATION CARD

ROBOMASTER CONTROLLER

This is the fast NEW PIC 16C55 RISC running at 20 MHz and 16 I/O IN/OUT lines and 2 strobes. Control it from any serial port at 9600 baud version or 115,200 baud version. With the 9 pin serial you can control anything you can think of A/D, D/A, ROBOTICS, ALARMS, SENSORS, REMOTE MODEM APP's. Use our preburned 16C55 I/O chip or the 16 model airplane servos real time chip, all chips use EZ4 or EZ16 COMMANDS. Board and one of these chips $89.95 or W/O chip $59.95 + $5.00 S/H Demo software Examples included.

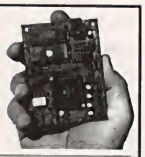
SEND CHECK or MONEY ORDERS to
P.C. PORTER
P.O. BOX 732
Titusville FL 32781-0732
(407) 268-4562 EST.

Fast D/A & A/D Modules Available Call For Price

CIRCLE NO. 82 ON FREE INFORMATION CARD

C-Programmable Networked
68HC11
MICRO CONTROLLER
with Application Libraries and Full Development Environment

NOW ONLY $89 IN QUANTITY



Speed development of prototypes and add powerful functionality to your product with the GCB11 Microcontroller and development software. The GCB11 provides full access to the 68HC11F1 processor, including 28 I/O lines and 64K of address space, and adds ready-to-use RS-232 and RS-485 communications as well as a 32K socketed RAM. Application libraries provided both on disk and in ROM reduce tasks such as instrument or motor control and data collection to a set of simple function calls. Your development is further simplified by a full set of menu based tools which allow C and assembly code to be compiled, downloaded, executed, and debugged from a PC. For distributed control, the GNET software provides full RS-485 multi-drop network communications using modular phone jacks, including the ability to monitor and control any node on the network from a PC.

COACTIVE AESTHETICS, INC
P.O. Box 425967 San Francisco, CA 94142
Voice: (415) 626-5152 Fax: (415) 626-6320
Internet: coactive@coactive.com

CIRCLE NO. 63 ON FREE INFORMATION CARD

Actual Circuit Emulation
A better method than ICE!

- **Much more power with less cost**
- **Drivers for LCD, DTMF, and more**
- **Versatile Interface Adapter on eBoard**
- **Simple expansion**
- **External power supply for 24 hour a day operation**
- **Cable, Breadboard, and Power supply**
- **All source included. Kernel, Forth, PC Debugger, Assembler and Environment.**
- **Runs independently of PC or use as a programmable PC card**

The eBoard ™

$195.25
This price is a limited time offer. Includes shipping and handling.

Object Oriented Hardware ™

Highlands Electronics
13720 LakeShore Drive
ClearLake, CA 95422
Phone 707 994-1024
Fax 707 994-5823

CIRCLE NO. 69 ON FREE INFORMATION CARD

SPY ON THE EARTH

See *live* on your PC what satellites in orbit see

Capture *live* breathtaking images of the Earth for fun or profit with our SpySat software and hardware package that does it all. Track, capture, display, zoom and analyze images directly from 6 or more environmental satellites. Complete Earth station package includes antenna, LNA, satellite receiver, demodulator, A-D converter and software, all for only $399 plus $25 shipping. For FREE information log-on to our bulletin board anytime at: (718) 740-3911. For information by mail send $5 (includes demo disk).

VANGUARD Electronic Labs
Dept. C, 196-23 Jamaica Ave.
Hollis, NY 11423 Tel.718-468-2720

MicroComputer JOURNAL

Classified Commerial Rates: $1 per word, 15-word minimun ($15.00) prepaid. (Word count includes name and address; Zip code and abbreviation each count as one word; P.O. Box number and telephone number count as two words each.) Indicate free category heading (Computers, Software, Electronics, Video or Miscellaneous). A special heading is available for a $6 surcharge. First word only is set boldface caps at no charge. Add 25¢ for each additional boldface word.
Non-Commerial Rates: FREE to subscribers, as space permits; maximun 15 words. A recent MicroComputer Journal mailing label must accompany ad. (All advertisers with P.O. box addresses must supply permanent address and telephone number. Copy is subject to publisher approval.)
Mailing Information: Copy must be received by the publisher by the 25th of the third month preceding the cover date. Send Advertising material with check or money order or credit card information (Visa or MasterCard only) with number and expiration date to: **MicroComputer Journal, 76 N. Broadway, Hicksville, NY 11801, Attn: Bernadette Schimmel.**

BUSINESS OPPORTUNITIES

ENTREPRENEUR'S HOTLINE BBS! Money-Making Reports, Email Technical Assistance, Specialized Files, Online Chat, Post Ads, Free Look! BBS# 206-678-4033.

SELLING my 900# for $210.00, for copy of contract, send $1.00 for postage to: Station Three, 111 W. Del Amo Blvd., Suite 6, Long Beach, CA 90805.

FOR SALE, AND DISTRIBUTION, SEVERAL (3) ABANDONED PATENT APPLICATIONS WITH USEFUL INFORMATION ABOUT EXISTING ELECTRONIC TECHNOLOGIES, USEFUL TO INVENTORS AND HOBBIEST, SEND SASE TO BOX 35-2812, MIAMI, FL 33135.

THE Ultimate Opportunity
If time, freedom and lack of income are stopping you, we need to talk! Phone 800-546-0204 for a 24-hour recorded message.

WANTED Audio Spectrum Analizer (in real time), kit, plans, chips, elsewere. I need One! Victor Acuna, Rawson 350, (1182) Buenos Aires, Argentina.

WINDOWS WINDOWS WINDOWS OPTIMIZE YOUR PERFORMANCE, SEND $5.00 TO: INNOVATIVE INFORMATION SERVICES, 2599 E. MAIN STREET, SUITE 514, BEXELY, OHIO 43209.

***FREE FREE FREE FREE**
Computer BBS 14.4, Internet Access, **1-215-445-1111**, * Regular Long Distance Apply.

CABLE TV

CABLE TEST CHIPS. Jerrold, Tocom, S.A., Zenith. Puts cable boxes into full service mode! $29.95 to $59.95. 1-800-452-7090,(310)902-0841.

CDROMS!

Supercharge your productivity with Walnut Creek's Simtel CDROM, 8000 files of quarterly updated MSDOS Shareware—only $29.95. Attention Window's Users: Cica Windows CDROM has all the current shareware you need $29.95. 3000 games Ciga Games for DOS and Windows, 600 meg Hobbes OS/2 CDROM, more. CALL NOW! 1-800-786-9907, info@cdrom.com, 1-510-674-0783 or fax 1-510-674-0821. Your library of utilities is complete with Walnut Creek CDROM's!

CABLE DOCTOR

Stop the bullet and ID signals in cable lines, send $20.00 to R.R. ENTERPRISE, DEPT. M, BOX 3532, EASTON, PA 18403.

COMPUTERS

Computers, TV, Phones and Technology. Solid information. Books, newsleter, BBS. New catalog $1 or voice/fax/BBS 716-874-2088. American Hacker, Suite 111, 1552 Hertel Ave., Buffalo, NY, 14216.

MEASURE and record **TEMPERATURE** with **LAPTOP** or PC using parallel printer port. Pocket-sized hardware under $100. Boone Technologies, P.O. Box 15052, Richmond, VA 23227. (804) 264-0262.

MAGAZINE supporting Z80, CP/M, S100, Kaypro, 8031, 6809 and more. **The Computer Journal.** 10th year of classic computer projects. Hardware, software, Forth, assembler. Micro-C Kaypro disks and schematics. 6 issues, $24, Free sample. (800) 424-8825. TCJ, P.O. Box 535, Lincoln, CA 95648

ELECTRONICS

FASCINATING kits! Lasers, voice changers, gas sensors, and more! Send $1.00 for catalog. LNS TECHNOLOGIES, 20993 Foothill Blvd., Suite 307C, Hayward, CA 94541-1511.

T.V. NOTCH FILTERS AND BULLET STOPPER, FREE BROCHURE. MICRO THinc. BOX 63/6025, MARGATE, FL. 33063 1-(305)-752-9202

CABLE TEST CHIPS, SA8550, SA8500-310, 311, 320, 321, (specify)-$38.95. 8580/338, 8570xxx, 8590xxx, 8590 (11 BUTTON)-$69.95. TOCOM 5503/07 VIP-$33.95. ZENITH ZF1-$33.95. STARCOM 6 (except BB)-$33.95. CABLE HACKERS BIBLE(s) VOL. 1. - $44.45, VOL. 2. - $44.45. CELLULAR HACKERS BIBLE Volume 1 -$53.95. CELLULAR HACKERS BIBLE Volume 2 - $79.95. CELLULAR CLONING VIDEO-$39.95. BAGPHONE VIDEO BIBLE - $39.95. CELLULAR PROGRAMMERS BIBLE - $84.45. Catalog - $3.00 Visa/Mastercard (24-HOURS), 602-782-2316 / FAX 602-343-2141 **TELECODE** P.O. BOX 6426-CC, YUMA, AZ 85366-6426.

ROMY-16 EPROM Emulator emulates 2716-27010 ROMs or 6116-628128 RAMs in 8- and 16-bit systems. Provides eight hardware breakpoints for 8-bit systems. **$195** (2716-27256) or **$245** (2716-27010). Optional assembler, disassembler, and ROM debugger for $100 each CPU. **Universal Microprocessor Simulator/Debugger V2.1.** simulates popular 8-bit microprocessors. Assembler, Disassembler, windowed symbolic Simulator/Debug- ger. $100 each CPU. **80C552 Development (Training) System $190.** 8051 family, Eight channel, 10-bit A/D. Watchdog timer, on-chip oscillator, RS-232 serial communication, one 8255A. 32K ROM, 64K RAM. Assembler, disassembler, on-board debugger and BASIC interpreter. $120 each board. optional 40x2 LCD display $20. **J&M** Inc. 83 Seaman Road, West Orange, NJ 07052, Tel: 201-325-1892, Fax: 201-736-4567.

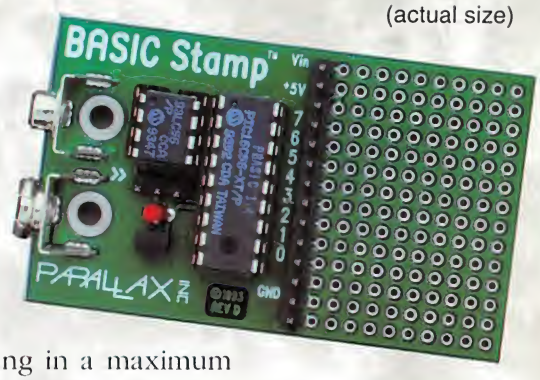
MISCELLANEOUS

ASIAN LADIES want correspondence for friendship, marriage. SUNSHINE INTERNATIONAL-Dept. TW, Box 5500, Kailua-Kona, Hawaii, 96745. (808)325-7707.

BASIC STAMP™

Stamp-Sized Computer Runs BASIC

(actual size)

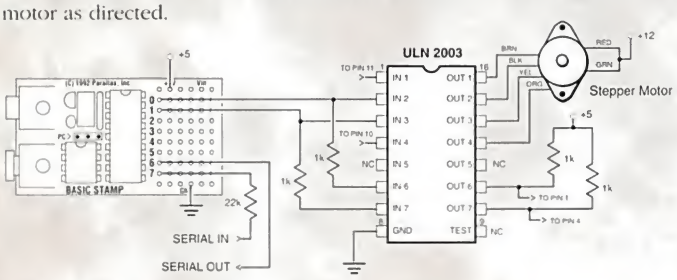


The BASIC Stamp is a small single-board computer that runs BASIC programs. It has 8 I/O lines, which can be used for a variety of digital and analog purposes. The Stamp's BASIC language includes familiar instructions, such as GOTO, FOR...NEXT, and IF...THEN, as well as SBC instructions, such as SERIN, PWM, and BUTTON. Each instruction takes 2-3 bytes of the Stamp's 256-byte EEPROM, resulting in a maximum program size of 80-100 instructions. Programs execute at about 2,000 instructions per second.

The BASIC Stamp Programming Package contains everything you need to program Stamps using your PC. The package includes our editor software, programming cable, manual, application notes, and free technical support. The package is available for $99; Stamps are sold separately for $39.

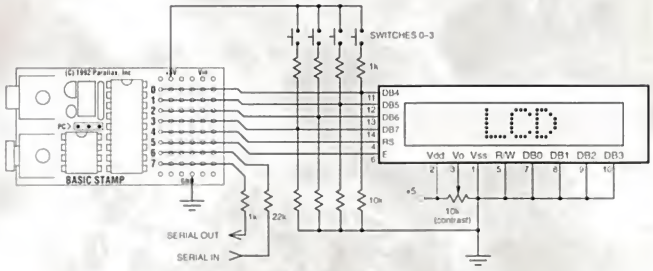
Stepper Motor Controller

This circuit makes the Stamp into a remote stepper motor controller. Using serial communications, the Stamp sends out a request for number of steps and delay between each. When it receives the data, the Stamp steps the motor as directed.



Micro-Terminal

In this application, the Stamp receives serial data and displays it on the LCD. The state of the four buttons is then transmitted serially.



PIC®16Cxx MICROCONTROLLERS and TOOLS

In price and availability, nothing compares to PICs.

PICs are the answer to many small controller needs, especially if price is an issue. A typical PIC is the PIC16C54-RC/P; it's an 18-pin DIP package with 12 I/O lines, 512 words of PROM, and 32 bytes of RAM, all for around $4.00 in small quantities. And newer PICs have interrupts, A/D, and up to 33 I/O lines.

For the past three years, we've been helping people get started with PICs. We offer a growing line of development tools, documentation, application notes, and technical help, as well as the PICs themselves.

If you'd like information on our PIC tools, or you'd like a copy of our complete catalog, please let us know. We'll be happy to send whatever materials you need.

PIC Chips **$4 - $27**

We offer PICs in the "RC" and EPROM versions.

PIC16Cxx Programmer **$199**

Supports PIC16C5x, '71, & '84. Also PIC16C64 with 40-pin adapter.

Reflection '5x™ **$249**

I/O simulator provides software simulation and in-circuit I/O.

ClearView '5x™ **$699**

In-circuit emulator provides full hardware debugging at 20 MH

PARALLAX inc
3805 Atherton Road, #102 • Rocklin, CA 95765 • USA
(916) 624-8333 • Fax: 624-8003 • BBS: 624-7101

50,000 pages of technical hardware information at your fingertips.

The Complete PC Hardware Reference.

The Micro House Technical Library on CD-ROM provides technical specifications and configuration information on over **1500** different manufacturer's products. We've taken thousands of hardware product manuals and extracted the vital information you need. Locating main boards, network interface cards, hard drives, hard drive controllers, and I/O cards (video, sound, modem, serial, parallel, CD-ROM, etc.) is now a reality. This feature rich CD-ROM even includes drivers and support software, from the manufacturers themselves!

MICROSOFT® WINDOWS™ COMPATIBLE

yes It runs with NetWare

AUTHORIZED NOVELL 801 COURSE — MICRO HOUSE — TRAINING PRODUCT

Call 800-926-8299 for a free demo and additional information!

International Inc. • 4900 Pearl East Circle • Suite 101 • Boulder, Colorado 80301 • 303 443-3388 • Fax 303 443-3323

ON FREE INFORMATION CARD

Ref: Part# TCMCJB